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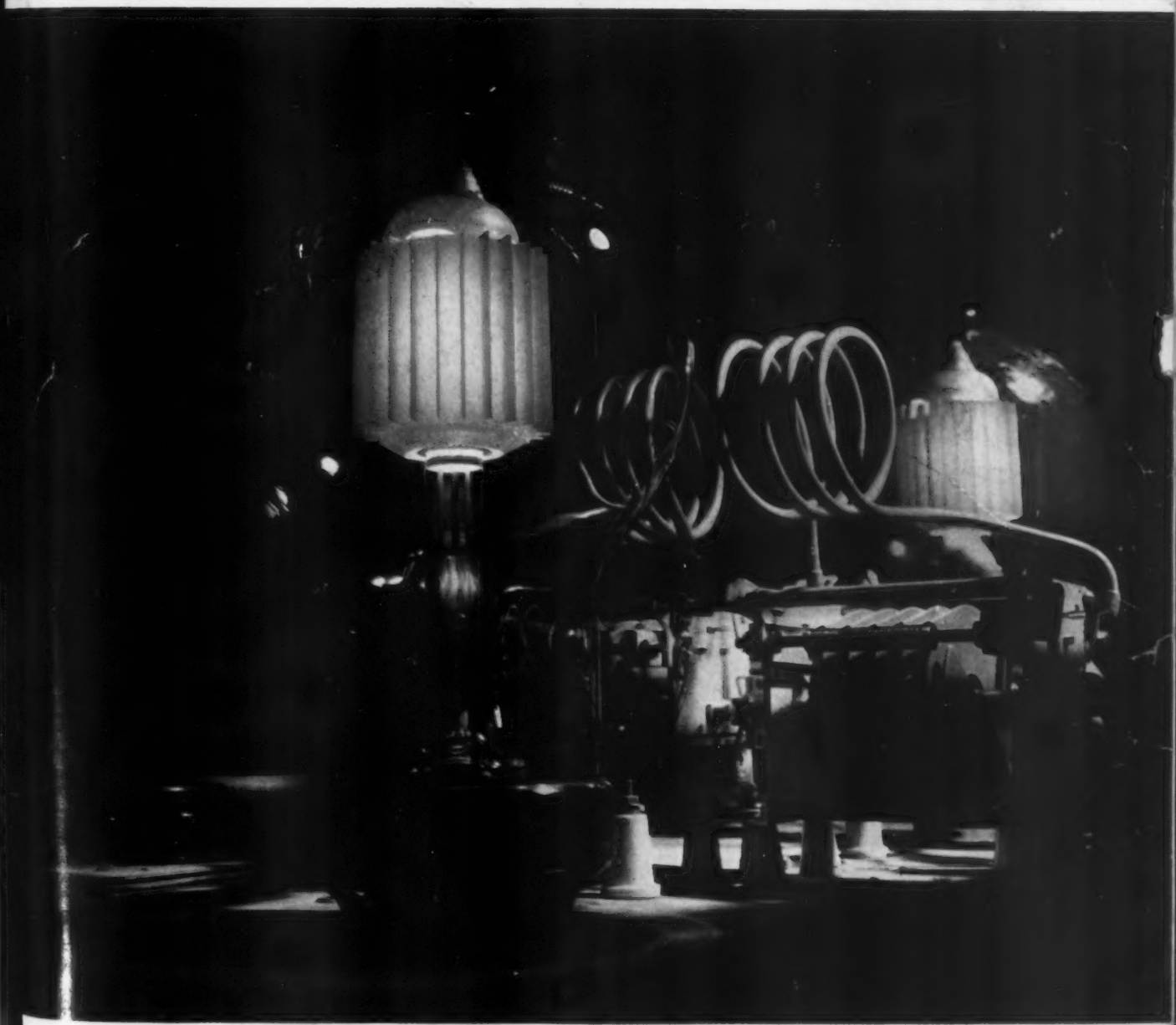

In this Issue: **PRODUCTION PROCESSES**—A 16-Page Special Section

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IN THIS ISSUE

Cover Picture—Transmitting tubes under dynamic test, which also serves to stabilize tube characteristics. Kodachrome courtesy Eitel-McCullough, Inc.

Production Processes and Methods

Engineers have the important responsibility of incorporating in their designs features which will enable the shop to facilitate machining and fabricating, and promote ease of assembling, therefore, the techniques of the several produc-

tion processes must be kept constantly in mind. The special editorial insert, see page 249, summarizes some of the principal processes and methods used in manufacturing parts and products by casting, forming, assembling, heating and surface treating. Special emphasis is given to materials, tooling costs, size limitations, dimensional accuracy, and other design considerations.

Cemented Carbides

The outstanding hardness, wear resistance, and other unusual properties of cemented carbides, which account for applications in cutting tools and dies, are also bringing this metal into wide use as an engineering material for improving product design, as illustrated in the article beginning on page 217. Cemented carbides are used in the form of small inserts attached to the main members by methods that are described in this article. Because of lowered cost of material and improved fabricating methods, parts weighing more than 100 lb. are economical in some applications.

Fatigue Failure in Shear Panels

Results of shear fatigue tests, made to evaluate the fatigue life of various magnesium and aluminum alloy sheets fabricated with aircraft rivets, are described on page 222 by E. R. Schenkel of Consolidated Vultee Aircraft Corporation. Conclusions are presented in chart form. The effect of improperly driven rivets on fatigue life is discussed from data obtained with specially constructed test pieces.

Formed Parts Classified—II

Formed sheet metal parts have been sub-divided into 23 classes of shapes under six defined general types of parts as a convenience in designing and to give greater assurance that parts will be designed in such a way as to be most easily fabricated. The first six classes were covered in March PRODUCT ENGINEERING. Part II, beginning on page 241, continues in the same vein with a discussion of design factors and listing of suitable forming methods for seven more classes.

Hardness Testing

The usefulness of the hardness test as a non-destructive check on a number of mechanical properties has long been recognized. Its application requires, however, careful evaluation of the various factors involved. T. H. Gray, research engineer, Westinghouse Electric & Manufacturing Company, discusses these in his article beginning on page 236.

Valves Used in Hydraulic Systems

Selector and relief valves, as used in hydraulic systems, are described on page 265 by Howard Field, Jr. The author analyzes and classifies the various types of valves and gives information as to design, characteristics, uses, and operating difficulties. Numerous types of valves are shown in sketches which indicate the wide range of selection available to the designer of a hydraulic system.

Speed and Torque Ratios In Epicyclic Gears

A sequel to the article "Limitations of Epicyclic Gearing for Variable Speed Drives," by J. F. Allen, October 1944 PRODUCT ENGINEERING, in which was discussed power, speed and efficiency relationships in epicyclic variable-speed drives. Edward F. Obert, Northwestern Technological Institute, see page 270, presents a method for calculating input and output speed ratio from torque relations without making the conventional kinematic tabulation of the relative motions of each gear. The method shows clearly the torque on each individual gear that should be used as a basis of design.

Frictional Supports

Relative longitudinal and rotational adjustment between a rod and a clamping member has been accomplished by innumerable methods. Two pages of suggestive illustrations of such devices that have proved satisfactory under different conditions of operation are presented on pages 272 and 273. These supports include those with adjustable frictional resistance and one with greater longitudinal friction in one direction than the other.

Brazing Costs

Cost evaluation is the key to successful development engineering, and brazing, long considered a maintenance and repair operation, when properly used in design, offers opportunities for savings not possible with other assembly methods. O. A. Kehle, of Adel Precision Products Corporation, in his article on page 274, shows how a careful analysis of the components of complicated parts leads to a furnace-brazed assembly with savings of 50 percent in some cases.

Stresses in Flywheel Spokes and Rim

Method for calculating stresses in the spokes and rims of flywheels caused by the action of centrifugal force and bending moments. See 'Reference Book Sheets, page 287. Data contributed by M. F. Spotts, Northwestern Technological Institute.

MAY HIGHLIGHTS

Ordnance Redesigns, by Max Salkin. Application of new materials and processes in ordnance, with illustrative examples.

Brakes and Clutches, by L. D. Hagenbook. Design formulas for determining tensions and pressures developed in simple band and adjustable band types.

Countersunk Bolts and Screws, by T. Rieben. An investigation of allowable shear and tension loads for nuts and countersunk head bolts and screws with recessed heads.

New Adhesives for Built-Up Assemblies, by Dr. G. G. Havens and George Gordon. Properties and application of Metlbonds.

Engineering Personnel and Cost Control, by James E. Thompson. Discussing handling of personnel and methods of cost control in an engineering department.

Design of Hydraulic Accumulators, by Howard Field, Jr. Describes the various types of accumulators used in hydraulic systems and evaluates them as to their characteristics.

The recently announced Fairchild Packet C-82, aptly called the "flying boxcar," is a versatile carrier that can quickly load and take off with 18,000 pounds of trucks, troops or other cargo. That, we all know, is no small achievement.

When the C-82's designers totaled the weights and found they had more than 12 tons dead load on each wheel, they called on Summerill to produce the special steel tubing for the main legs of the landing gear. We're proud to say that we did it!

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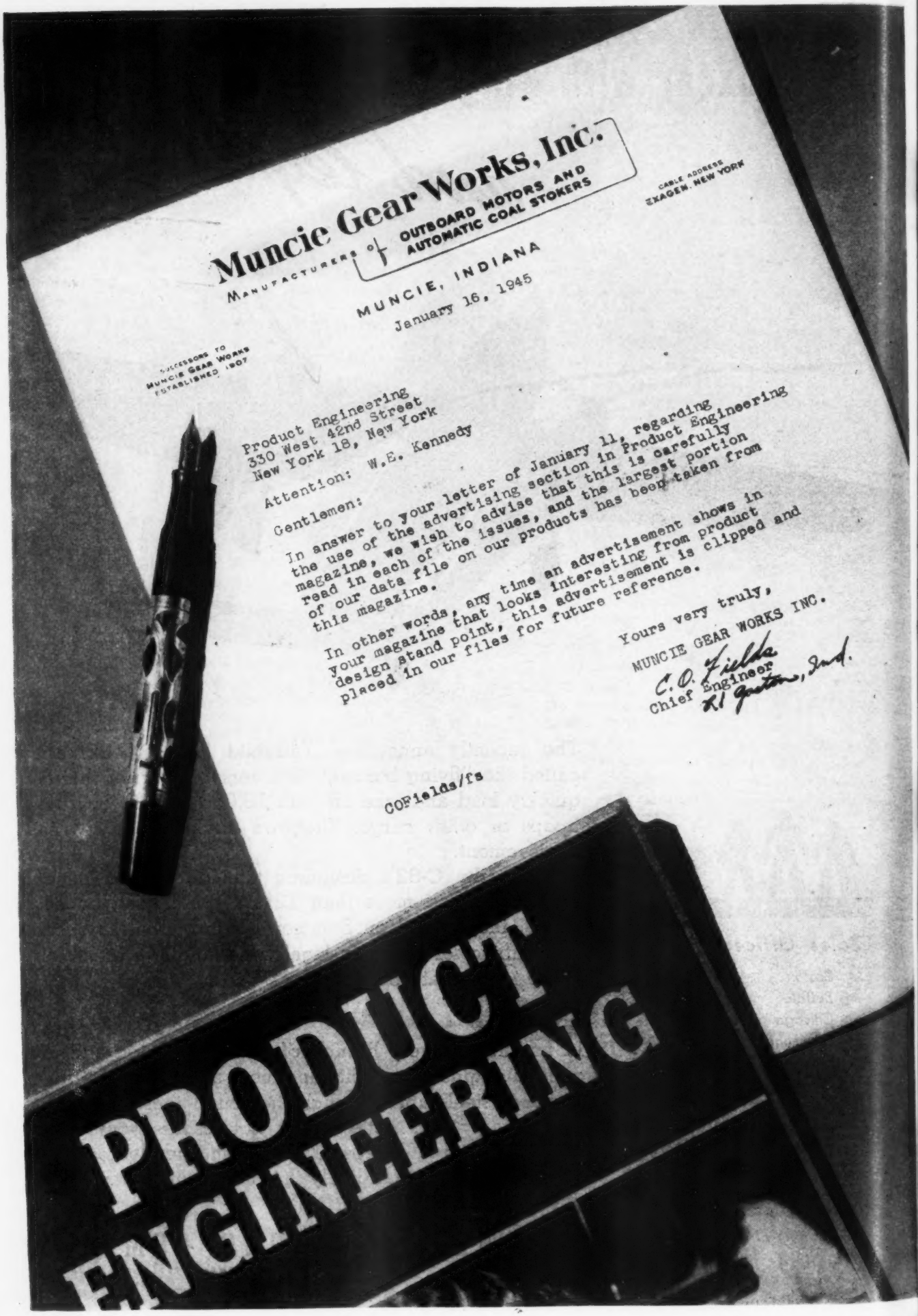
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330 West 42nd Street
New York 18, New York
Attention: W.E. Kennedy
Gentlemen:
In answer to your letter of January 11, regarding the use of the advertising section in Product Engineering magazine, we wish to advise that this is carefully read in each of the issues, and the largest portion of our data file on our products has been taken from this magazine.
In other words, any time an advertisement shows in your magazine that looks interesting from product design stand point, this advertisement is clipped and placed in our files for future reference.
Yours very truly,
MUNCIE GEAR WORKS INC.
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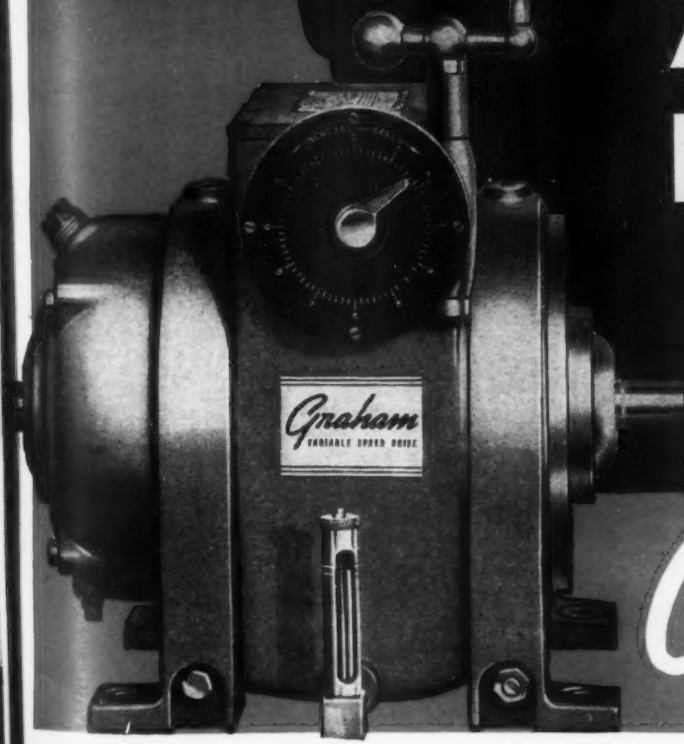
FOR YOUR POST-WAR MACHINE USE A *Graham* VARIABLE SPEED DRIVE

O OTHER VARIABLE SPEED TRANSMISSION GIVES YOU EVERY SPEED FROM TOP TO ZERO and REVERSE!



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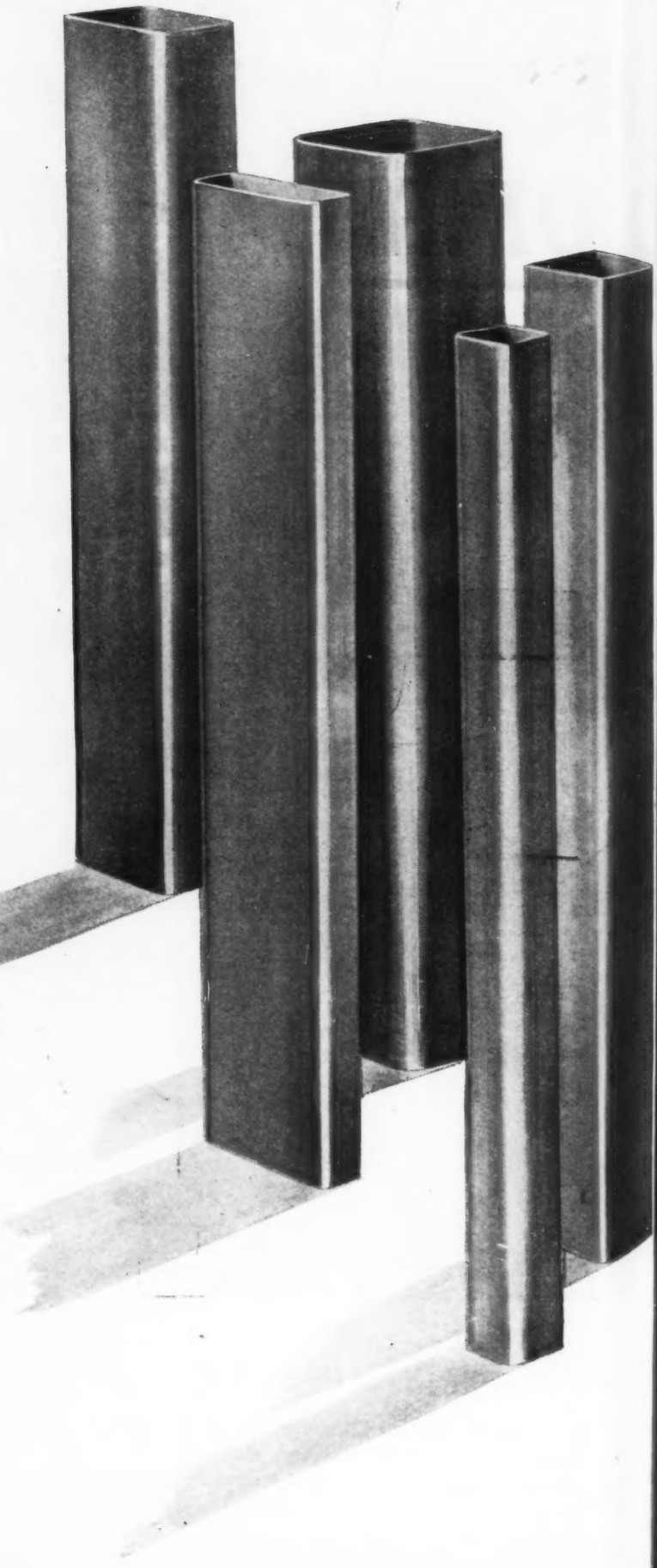
WRITE FOR BULLETIN 506

GRAHAM TRANSMISSIONS INC., 3754 NORTH HOLTON ST., MILWAUKEE 6, WIS.

Square and Rectangular Aluminum Tube ...by REVERE



Do you know that —

Revere makes other than round aluminum alloy tubes.

The quality and service established by Revere on round tubes is now available in square and rectangular shapes.

These tubes are now used chiefly in aircraft structural members. They combine lightness with strength and rigidity.

Square and rectangular tubes are drawn from round to provide physical properties that meet specifications for either the S-O (soft) or the S-T (heat-treated) condition.

Dies are available for a wide range of sizes and shapes. New designs may be created to meet new engineering needs.

Eventually, when metal and facilities exceed the needs of war, these tubes will have many important uses in products for civilians. Remember Revere's extensive experience in working aluminum to the most exacting military standards when planning for the future. For full information, write Revere Executive Offices.

REVERE

COPPER AND BRASS INCORPORATED

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From jitterbug ride to velvet glide — by rubber

A typical example of B. F. Goodrich development in rubber

THE postwar bus is already developed —and jiggles, bangs, bounces, and bumps are gone. Years ago, B. F. Goodrich engineers realized that, in addition to rubber tires, the shock-absorbing qualities of rubber could be used in springs, too, for greater riding comfort.

Finally, just before the war, they developed a "rubber hip" that suspends an automobile or bus body in soft, cushioning rubber. This device, the Torsilastic spring, is a steel cylinder placed lengthwise to the frame. Inside is a shaft. Space between cylinder and shaft is filled with rubber, attached by permanent bond to both metal surfaces. The weight of the bus gives a slight twisting action to the rubber.

Road shocks are lost in the rubber — they cannot pass through it to the car frame. The result is the "velvet ride" that has been the aim of automobile designing for decades.

War put a stop to use of natural rubber for this new spring. But now enough synthetic rubber has been released by the government to equip new Twin Coach buses badly needed for wartime transportation . . . their passengers will be floating on rubber and sitting pretty.

Some automotive men say the bus developments of today will be on your automobile tomorrow, so the rubber spring for the velvet glide may be on your postwar car — another contribution of B. F. Goodrich research. *The B. F. Goodrich Company, Industrial Products Division, Akron, Ohio.*

B.F. Goodrich

RUBBER *and* SYNTHETIC *products*

If you are designing...

UNITED

remember—9 TIMES OUT OF 10

STEEL WILL DO IT BETTER

ON your drawing boards the world of tomorrow is already taking shape. And rightly so. For who can deny that while our primary effort now is to outfight and defeat the Axis, a necessary part of winning the Peace is wise and proper planning for the future.

As creators of the things to come, you design engineers face a grave responsibility. For on the commercial soundness of your thinking ahead will largely depend the postwar prosperity of American business and industry. Your drawing board dreams will have to be eminently practical.

Your product, whatever it is, must first of all fill a real need. And it must be able to meet competition either by its superior quality or its lower cost.

That is why we remind you not only of steel's outstanding versatility, but of its proved economic superiority.

What other material can be had in so many different forms or with such widely different properties—or can be used in so many different ways for such widely different purposes—as steel? Where can you find a material, old or new, that can so readily meet every fabricating demand?

Steel, and especially the new steels developed during the war, gives you almost unlimited freedom of action both in design and application. Whatever quality your product needs—strength, toughness, light weight, endurance or beauty—steel can provide it. And generally at lower cost.

Let us help you look further into this matter of steel. Our technicians will gladly consult with and advise you.

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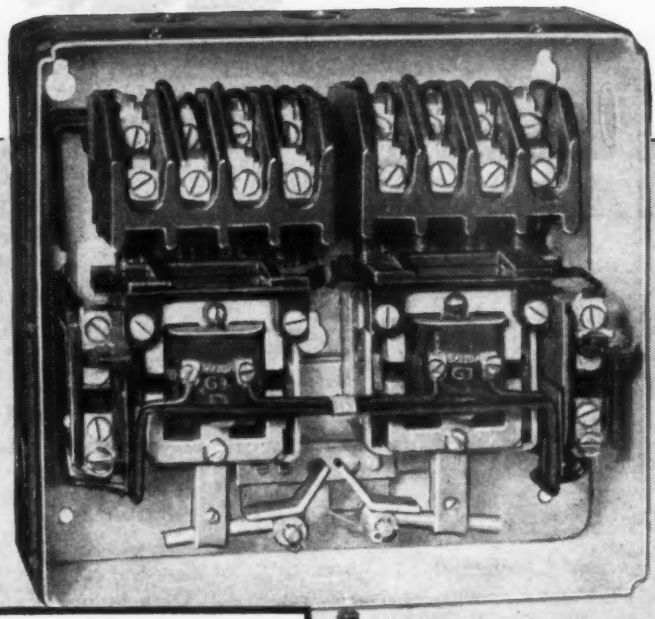
New REVERSING STARTERS THAT POLICE ARCING

Announcing a simple, new mechanical INTERLOCK



Designed to "go well" with modern machines, these trim reversing starters (Types CR-7009-B50 and B51) are equipped with the new G-E mechanical interlock for short-circuit protection. Multi-speed starters (Types CR7107-K50 and K51) are also equipped with this new G-E device.

ARCING that occurs when a contactor opens during reversing is a virtual "fifth column" bridge for possible damaging short-circuit currents, if the arc is not extinguished *before* its companion contactor closes. To minimize this hazard, General Electric has developed a new mechanism that, for all practical purposes, prevents its occurrence—the G-E semi-interference mechanical interlock.

This new and inexpensive safety feature is now standard on the CR7009 reversing starter, up to 1½ hp, single-phase, and up to 7½ hp, polyphase; also on the CR7107 multi-speed starters, up to 7½ hp.

These G-E magnetic starters are available in several standard forms to meet your electrical requirements and to fit in the space your design allows. You can install them on your equipment with full confidence in their performance, in their ability to handle the toughest loads that may be imposed upon them.

G.E. has many types, sizes and combinations of controls, and a broad, versatile line of electric motors, for manual or automatic operation of machinery. To aid your selection, our application engineers can give you unbiased recommendations. *General Electric Co., Schenectady 5, New York.*

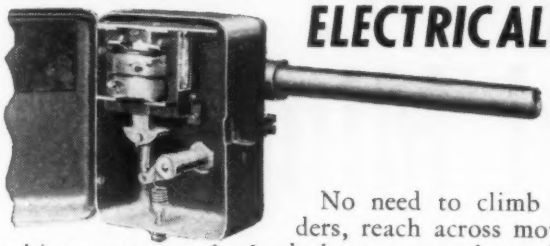
Buy all the BONDS you can—*and keep all you buy*

GENERAL ELECTRIC

Digest

TIMELY HIGHLIGHTS ON G-E PRODUCTS

OPEN HARD-TO-GET-AT VALVES ELECTRICALLY

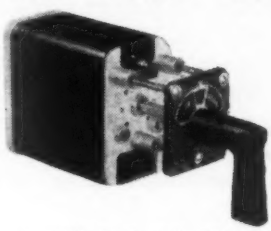


No need to climb ladders, reach across moving machinery, or grope in the dark to open or shut valves. It's much simpler, safer, and quicker to install a push-button operated G-E solenoid valve. The valve bodies are made of bronze, cast iron, monel metal, or cast steel, for a variety of service applications, in sizes up to 2 in. Other types available in larger sizes. Ask for Bulletin GEA-1423A.

FOR HIGH ACCURACY—LONG LIFE

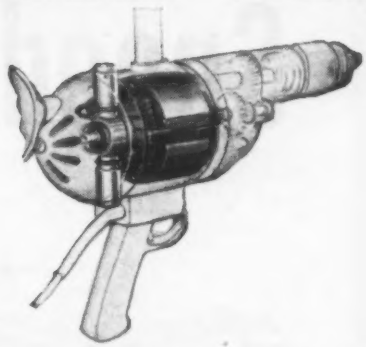
These thin, internal-pivot panel instruments have high torque, good damping, and a lightweight moving element that withstands vibration. They respond rapidly and accurately. They give you more instrument in less space, because the internal-pivot construction makes the entire element assembly 20 per cent thinner than outside-pivoted types. Write now for details of the Type DW voltmeter or ammeter—milli, micro, or radio frequency. Bulletin GEA-4064.

THERE ARE 4000 WAYS YOU CAN USE THIS SWITCH



For most ordinary control and transfer switching jobs, you'll find a standard SB-1 switch will fit in ideally with your designs. But where requirements are unusual, special switches can be made from standard cams, contacts, and other parts. Already, more than 4000 different arrangements have been made. Every circuit designer should have a copy of the booklet that describes the flexibility of this switch. Ask for Bulletin GEA-1631D.

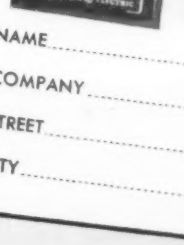
The case of the DISAPPEARING MOTOR



For your designs that call for hidden motors, G.E. can furnish several types, including shell-type squirrel-cage motors (stator and rotor only), series-motor parts (stator, wound rotor, and brush mechanism), and governor-controlled series motors completely assembled for mounting inside machines. You have complete freedom of design in incorporating these basic motor components as a built-in power source.

More and more portable tools, machines, and appliances are being electrified by motors that "disappear" within a form-fitting "case" designed by the product manufacturer. The phantom view, for example, shows a set of high-speed, series-motor parts that form an integral part of a drill assembly, yet are out of sight of the user.

Operating speeds: shell-type motors, up to 120,000 rpm; series-motor parts from 2000 to 14,000 rpm; governor-controlled units, 2000 rpm. Ask for detailed information on the particular type of disassembled motor components, or assembled units, to handle your next "inside" job.



General Electric Company, Section C668-34
Schenectady 5, N. Y.

Please send me the following bulletins:
GEA-1423A—solenoid valves
GEA-4064—instruments
GEA-1631D—SB-1 switch
GEA-4092—built-in motors

NAME .....
COMPANY .....
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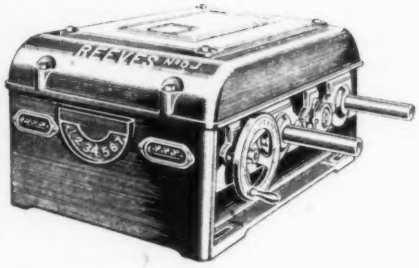

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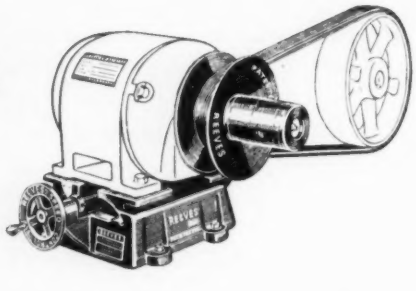
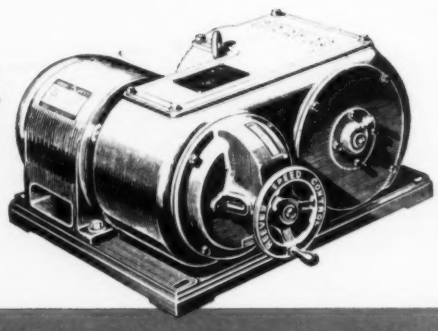


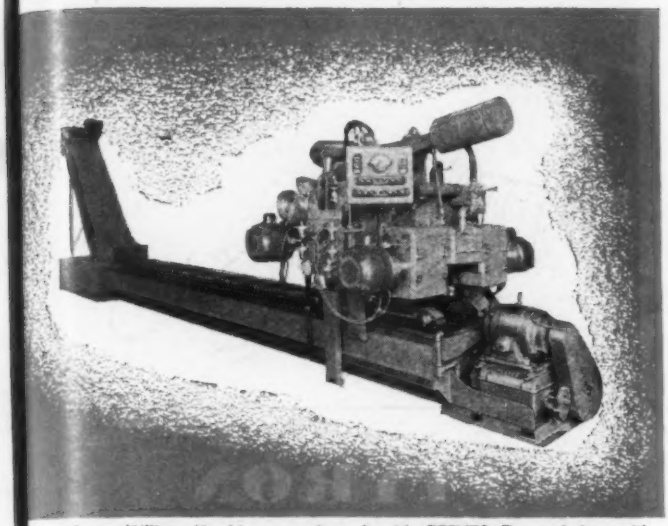
REEVES VARI-SPEED MOTOR PULLEY. Converts any standard, constant speed motor into a variable speed drive. Forms actual driving element between motor and driven machines. Consists of an assembly of two facing, cone-shaped discs, a motor base with adjusting handwheel, and a REEVES V-belt. Disc assembly is applied directly to standard motor shaft extension. By turning handwheel, motor is moved forward or back on base, varying driving diameter of discs on motor shaft and effecting stepless speed changes. Fractional to 15 h.p.; ratios of speed variation within 4:1.



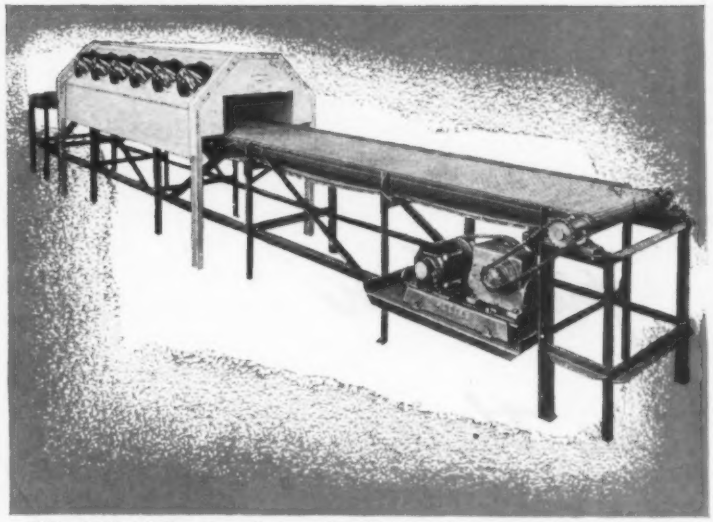
REEVES MOTODRIVE. A complete, variable speed power plant, combining constant speed driving motor, variable speed mechanism and speed reduction gears in one compact, self-contained unit. Embodies features of both the REEVES Variable Speed Transmission and Vari-Speed Motor Pulley. Any make foot type, ball bearing motor in standard NEMA dimensions may be specified. Available in horizontal and vertical designs. Sizes fractional to 15 h.p.; ratios of speed variation, 2 to 1—6 to 1.

CONTROLS for effecting speed changes may be handwheel, electric remote or completely automatic.

☆ **REEVES Speed Control units are simple, rugged, accurate. There are no delicate electrical or mechanical "gadgets" to require expert attention or repair. REEVES drives just keep rolling along year after year with minimum maintenance attention.**



nham Spar Milling Machine—equipped with REEVES Transmission with ctric Remote Control. Feed can be adjusted gradually and without stopping, conform with different sections to be milled, which vary from end to end.



Gifford-Wood Conveyor System for drying surface coated metals in continuous-flow production by "infra red" process. REEVES Motor Pulley provides proper timing for different sizes and shapes.

• Many improvements in the design and equipment of production machines have been made during this war. Some have been entirely new. Others, such as *speed adjustability,* have been greatly emphasized—brought into the spot-light—by demands for better and faster production.

Even in the production of peace-time goods, before the war, when the need for the utmost in speed of production and flexibility of processes was not so acute, the builders of more than 1,800 different makes of machines had adopted REEVES as standard equipment.

SIMPLE, RUGGED, ACCURATE

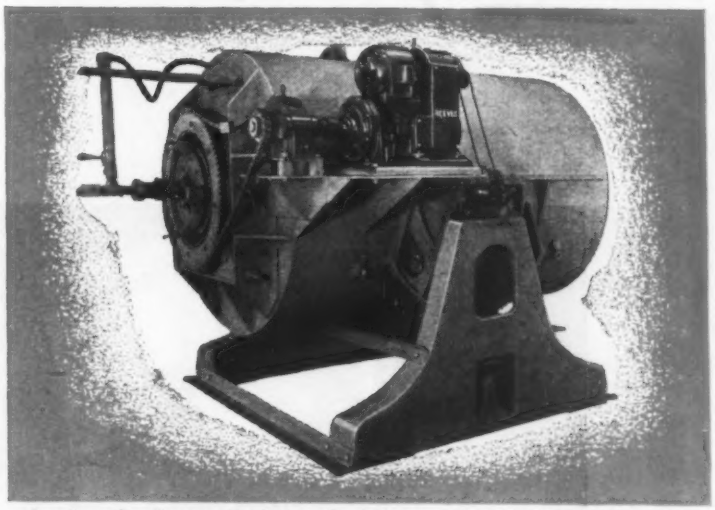
REEVES is the original, the tried and proven method of regulating machine speeds accurately to production demands. Its simplicity of design, and "fool-proof" operation have done more to make production men conscious of speed control's advantages than has any other method.

The fact that REEVES Speed Control is provided in three basic designs instead of one, that it is built in many sizes, and that even internal operating parts, without cases, are available for installation within the frames of machines, have all contributed greatly to its popularity for standard equipment. These are reasons why REEVES Speed Control has done so much to create the greater appreciation for speed adjustability *as a principle,* as well as a method, throughout industry.

REEVES maintains a nation-wide staff of seasoned, speed control engineers to help you improve machine performance. For complete information, send for 96-page Catalog K-450.

REEVES PULLEY COMPANY • COLUMBUS, INDIANA

Recognized Leader in the Specialized Field of Speed Control Engineering



American Gas Furnace Co. Rotary Carburizer regulated by REEVES Motodrive to provide wide range of retort speeds and to insure proper speed for every desired heating period.

SECURE THESE OPERATING ADVANTAGES

Process different sizes, shapes, or grades of products on the same machine.

Compensate for changes in composition, molecular construction, density or character of material during processing.

Insure new exactness in heating, baking, drying, cooling, or chilling time.

Provide accurate flexibility to meet change in complete production schedule—new designs, new sequences of processing.

Maintain uniform peripheral speed on a decreasing or increasing diameter—in cutting, winding, unwinding.

Synchronize speeds of parts of the same machine or machines operated in series.

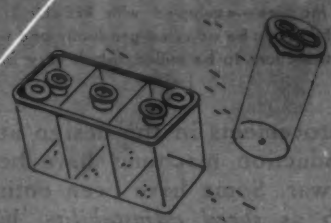
Match variance in number or skill of machine operators.

REEVES *Accurate Variable* Speed Control

put them in their RIGHT place!

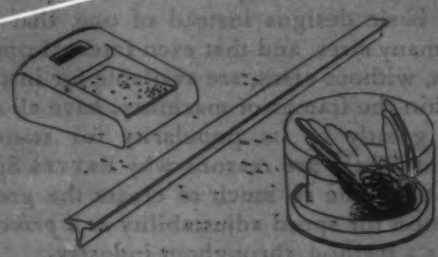
SARAN

STYRON



DOW

ETHOCEL



Let's work it out together

We at Dow know from experience that success in plastics is not a one-man nor even a one-industry job. It calls for the combined skill and cooperation of manufacturer or designer plus fabricator plus raw materials producer. Working together, this team saves time and money and puts plastics to work successfully. Call us—we'll do our part.

EASILY FABRICATED IN THESE FORMS

STYRON **(Dow Polystyrene) . . .**
For moldings, extrusions, rods, sheets.

SARAN **. . .**
For moldings, extrusions, pipe, tubing, sheet, monofilaments; also available as Saran Film.

ETHOCEL **(Dow Ethylcellulose) . . .**
For moldings, extrusions, coatings; available also as Ethocel Sheeting.

Present and Potential Uses

Plating masks; chemical apparatus; pump parts; valves and valve parts; name plates; meter parts; paint brush handles; insulation; stoppers; funnels; bottles; closures; plumbing parts and equipment; wire coating, etc.; pipe and tubing for installations requiring chemical and corrosion resistance.

Properties and Advantages

Resistant to chemicals, abrasion, corrosion, water, and moisture; good electrical insulator; excellent thermal insulator; nonflammable; tough; flexible; dimensionally stable; not recommended for installations requiring temperature resistance above 170° Fahrenheit; tends to brittleness at very low temperatures.

Present and Potential Uses

Lighting fixtures; insulators; battery cases; hydrometers; funnels; bottles; closures; food handling equipment; pharmaceutical, cosmetic and jewelry containers; costume jewelry; novelties; refrigeration parts; pens; pencils; liquor dispensers; escutcheons; chemical apparatus; dishes; lenses; decorative objects, trim.

Properties and Advantages

Clear, translucent or opaque; broad color range; excellent high frequency electrical insulator; can "pipe" light through rod at angles, around corners, etc.; resistant to acids and many alkalies; low water absorption; light weight; stable at low temperatures; limited solvent resistance; available only in rigid forms.

PLASTICS

Present and Potential Uses

Housings; radio cabinets; aircraft parts; containers; insulators; flashlights; automotive parts; escutcheons; refrigerator parts; tool handles; rods, tubes, bars, and special extruded shapes for kitchen trim; automotive and aircraft window frames; modern window blinds. Also used as tape and wire coating.

Properties and Advantages

Extra tough, particularly at low temperatures; attractive colors; pleasant to handle; transparent or translucent; dimensionally stable to varying climatic conditions and temperatures; light in weight; available in wide range of flow; not available in crystal color; limited chemical and solvent resistance.

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MIDLAND, MICHIGAN
New York • Boston • Philadelphia • Washington • Cleveland • Detroit
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PLASTICS
STYRON • ETHOCEL • ETHOCEL SHEETING
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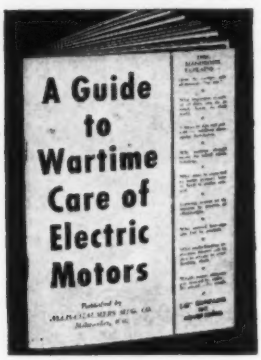
FIRST AID FOR MOTORS

MOTORS RUN A FEVER? No wonder if they do more often today. They're working *3 and 4 times* as many hours as in peace!

Wartime conditions demand you diagnose motor ailments *quickly* . . . remedy the trouble at once. At right are but few of the many diagnoses found in Allis-Chalmers' new "Guide to Wartime Care of Electric Motors". In maintenance as in war, *attack is the best defense.* This book singles out the 9 main enemies of electric motors . . . tells you how to get them *before* they get your motors!



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SYMPTOMS YOU CAN SEE

Symptom	Possible Causes	Cure
1. Excessive sparking or flashing at brushes. Blackened commutator.	Rough commutator.	Sand or turn down, depending upon depth of surface roughness.
	Low bar on commutator.	Grind or turn down balance of commutator.
	High bar on commutator.	If extreme, lower with mallet, tightening clamping ring. Grind true.
	Brushes too short.	Replace with harder grade—if worn too soon . . . and not by rough commutator.
	Shorted armature winding.	Test for short—after removing metallic contact between commutator bars. Repair.
2. Intermittent sparking at brushes.	Open armature winding.	Locate and replace bad coil—or repair defective joint.
3. Motor won't start.	Usually line trouble.	Correct. Check source of power supply.
	Load too heavy. See if motor runs without load.	Reduce load—or replace motor with unit of greater capacity.

SYMPTOMS YOU CAN HEAR

4. Excessive hum.	Uneven air gap. Measure with feelers.	Replace bearings—before introduction of scraping noise indicates rotor is rubbing.
	Unbalanced rotor. Check on parallel bars.	Balance with solder on band—or weight attached by cap screw and lock washer.
5. Regular clicking.	Matter in air gap.	Take out rotor; remove matter.
6. Rapid knocking	Misalignment.	Realign set until knocking disappears.
7. Brush "chatter."	Extreme vibration.	See item 10, below.

SYMPTOMS YOU CAN FEEL

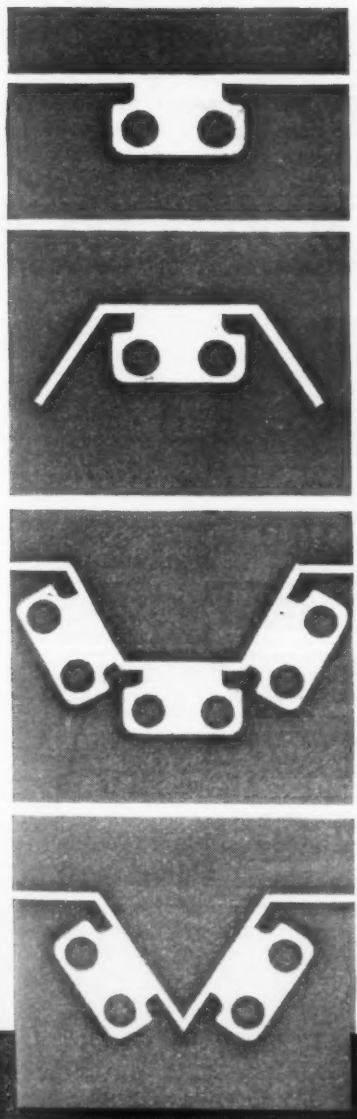
8. Vibration.	Misalignment.	Realign set.
	Vibration in driven machine.	Eliminate source in machine, if possible. Or a flexible belt drive may be in order.
9. Motor overheating. (Check with thermometer—don't depend on hand).	Overload. Measure load; compare with nameplate rating.	Check for excessive friction in motor, drive or machine. Reduce load, or replace motor with greater capacity unit.
	Dirt in motor. Check flow of air.	Blow out motor. Use solvent on wound section if necessary.
	Rotor rubs stator.	Replace bearings.

A 1638

ALLIS-CHALMERS MOTORS

When you do need new motors, look into the strength, solidity and all-around protection of the new "Safety Circle"—protected top, sides, ends and bottom.

AC WE WORK FOR VICTORY WE PLAN FOR PEACE



HIGH-POWER Factor Ballasts . . . Watch Dog Starters . . . Slimline Lamps . . . and now General Electric introduces the new G-E Twin Turret Lampholder. The Turret represents another result of G.E.'s constant effort to provide more efficient and dependable lighting fluorescent service.

The G-E Twin Turret Lampholder is designed for 40-watt fluorescent lamps. It is constructed of sturdy metal. Starter receptacles are located between lamps to accommodate either FS-40 G-E Watch Dogs or the standard FS-4 starters. The Turret is available only in white.

How the Turret works—Lamps are inserted by depressing either face of the Turret with one end of the lamp until the other end clears the opposite face and slips in place. The Turret holds the lamps securely in contact.

TURRET FEATURES

- The Turret eliminates the costly replacement of broken lampholders once and for all.
- It provides maximum protection against the hazard of lamps falling out of fixtures.
- Maintenance men need no longer waste time fussing with safety gadgets.
- The Turret's pleasing design will add to the appearance and value of any fluorescent lighting fixture.

For additional information write to Section Q454-42 Appliance and Merchandise Dept., General Electric Co., Bridgeport, Conn.

BUY WAR BONDS AND KEEP THEM

Hear the General Electric radio programs: "The G-E All Girl Orchestra" Sunday 10 P.M. EWT, NBC. "G-E House Party" Monday through Friday 4 P.M. EWT, CBS.

GENERAL ELECTRIC

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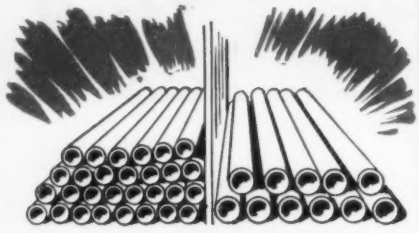
Answer to Industry's No. 1 Question

Today . . . With R301 and the other new high-strength alloys, aluminum combines light weight, corrosion-resistance *and great strength* . . . extends farther and farther the rapidly widening field of its usefulness.

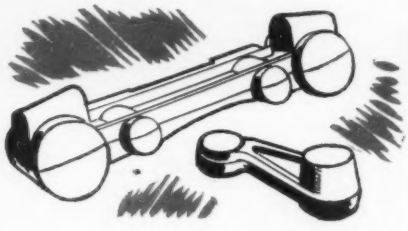
Today . . . To known prewar facilities Reynolds adds a great new independent source of supply and service . . . mines . . . manufacturing plants in the great industrial areas.

Never again need America face the danger of aluminum scarcity and high prices.

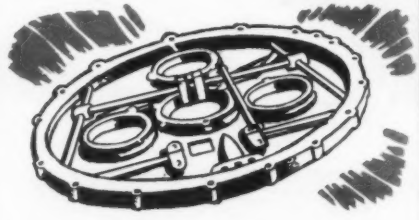
Sheet and Plate. Standard gauges, sizes and alloys. Many special items.



Tubing. Seamless. Closely controlled as to quality and dimensions.



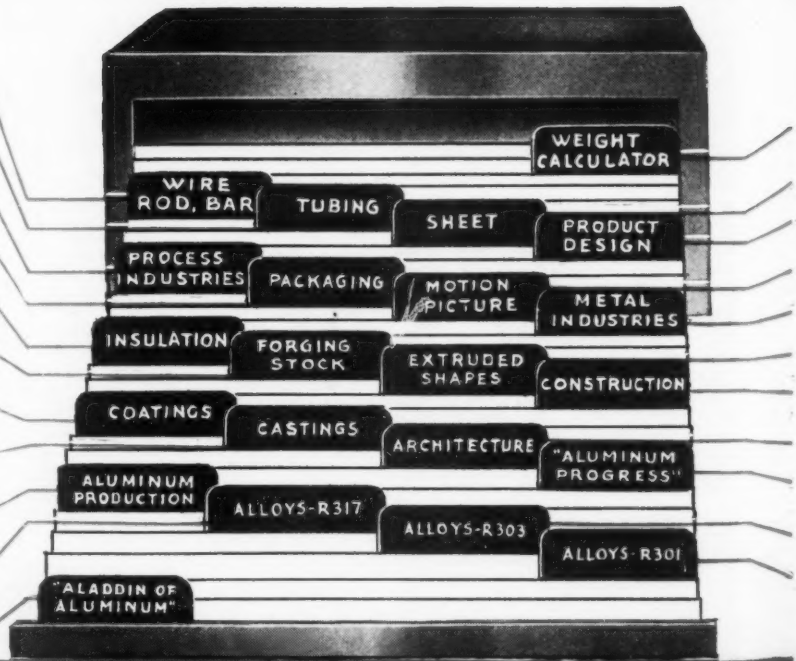
Forgings. Production capacity—up to 2,000,000 units per month.



Castings. Permanent mold and sand. Produced in one of industry's most modern plants.

BULLETINS ... CATALOGS ... OTHER MATERIAL ...

1. **Wire, Rod, Bar.** (Bulletin 31-A.) Specifications, ordering data, etc. 12 pages.
2. **Tubing.** (Bulletin 17-A.) Specifications, ordering data, etc. 8 pages.
3. **Process Industries.** "Reynolds Aluminum, its New Importance in Processing Operations." (Catalog 102.) 8 pages. (Now on press.)
4. **Packaging.** Bulletin on protective metal packaging for military and civilian application. 4 pages.
5. **Insulation.** Bulletin on types and applications of reflective metal insulation.
6. **Forging Stock.** (Bulletin 23-A.) Ordering data. 8 pages.
7. **Coatings.** Forms, applications, evaluation, etc. Powders and Pastes. (Bulletin 21-A.) 20 pages.
8. **Castings.** Descriptive bulletin of Reynolds facilities for sand and permanent mold castings. (On press.)
9. **Aluminum Production.** "From Bauxite to Rolled Metal," story and flow diagram of world's only complete aluminum plant. 8 pp.
10. **Alloys—R317.** A new free machining strong aluminum alloy.
11. **"Aladdin of Aluminum."** A Reader's Digest reprint, giving background story of Reynolds growth.



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REYNOLDS ALUMINUM

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you on ALUMINUM?

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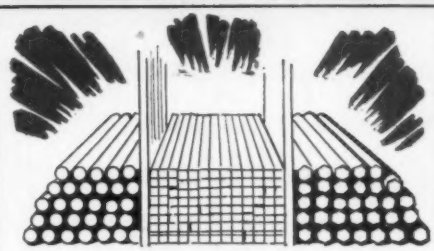
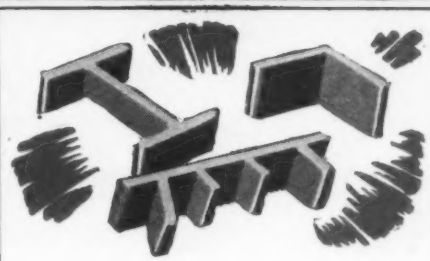
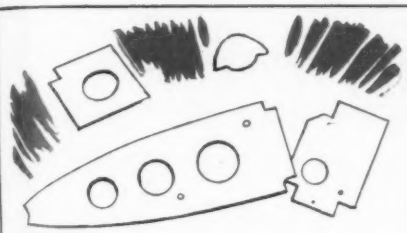


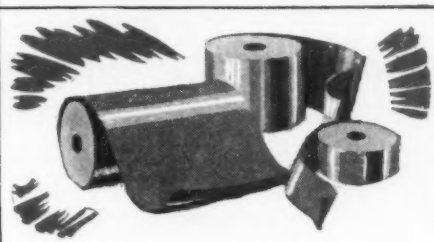
Rod and Bar. Sizes from ⅜ inches to 8 inches for forging and machining.



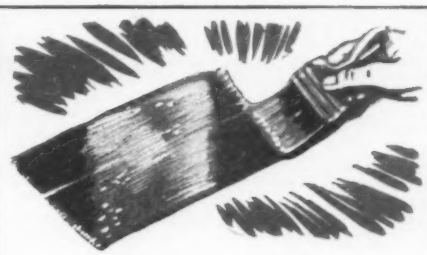
Shapes. Rolled and extruded sections to fulfill individual needs.



Parts. Fabrication at aluminum source saves manpower, plant space, scrap and transportation.



Foil. For years the largest producer of light gauge aluminum for packaging, technical and insulation purposes.



Powders and Pastes. For aluminum coatings.

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"Reynolds Aluminum, Its Important Role in Tomorrow's Products," is of great interest to every one concerned with design and production. 16 pages packed with useful information. Check 14 ... in coupon at right.

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Source of valuable technical knowledge

To the sum total of metallurgical knowledge Reynolds Metals has added much vital data . . . experience gained in pioneering new fields of aluminum production and product development—the use of improved machines and processes in the world's largest mills—the creation of new alloys, promise of even greater things to come.

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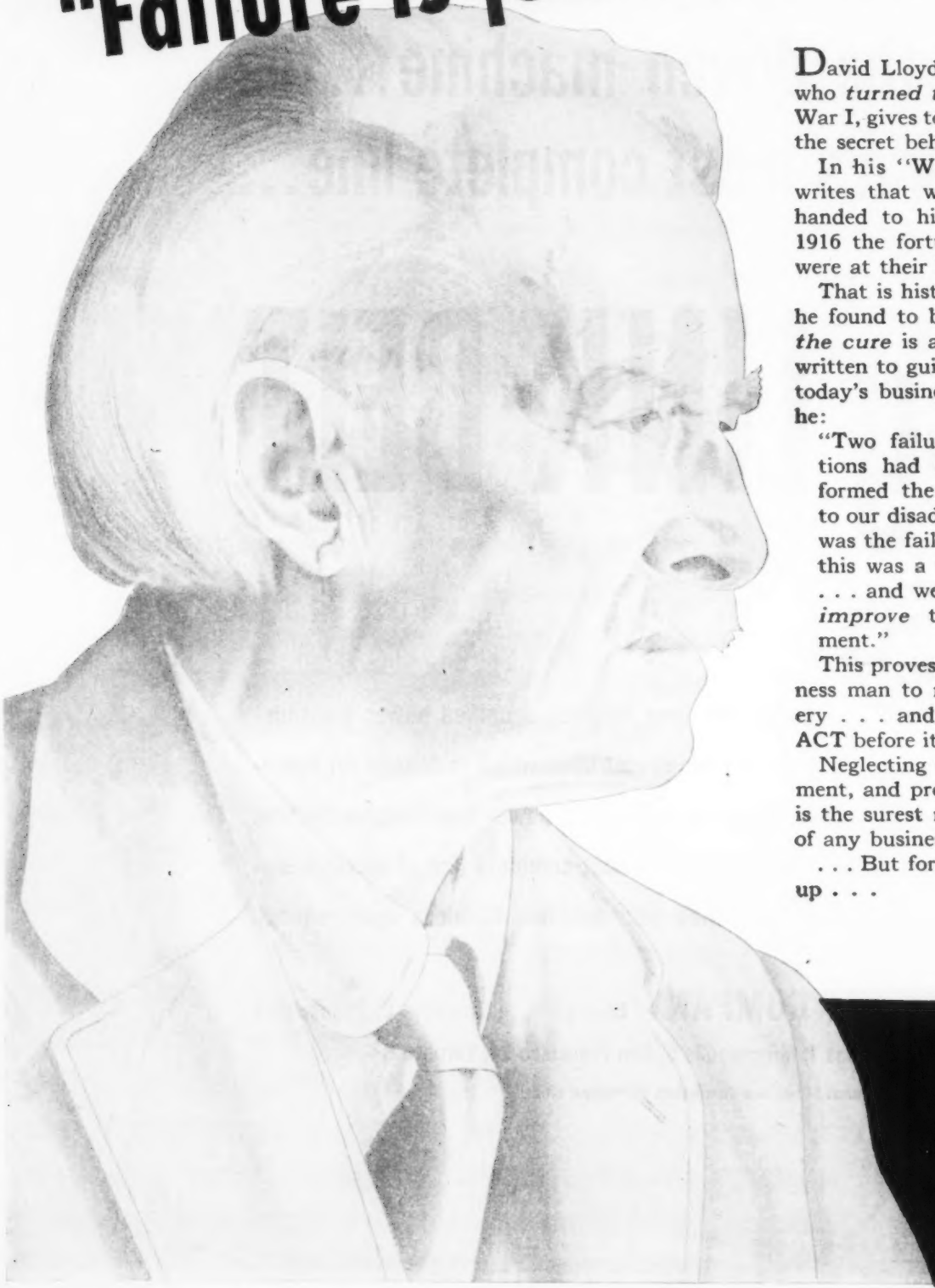
then he said to himself

"Failure is just a symptom"



David Lloyd George, the man who *turned the tide* of World War I, gives to postwar planners the secret behind that turn.

In his "War Memoirs" he writes that when the war was handed to him at the end of 1916 the fortunes of the Allies were at their lowest ebb.

That is history . . . but what he found to be *the cause* and *the cure* is as fresh as though written to guide the strategy of today's business planners. Says he:

> "Two failures on key questions had completely transformed the military position to our disadvantage. The first was the failure to realize that this was a war of machinery . . . and we had neglected to *improve* the Allied equipment."

This proves he is a good business man to make that discovery . . . and a better man to ACT before it is too late.

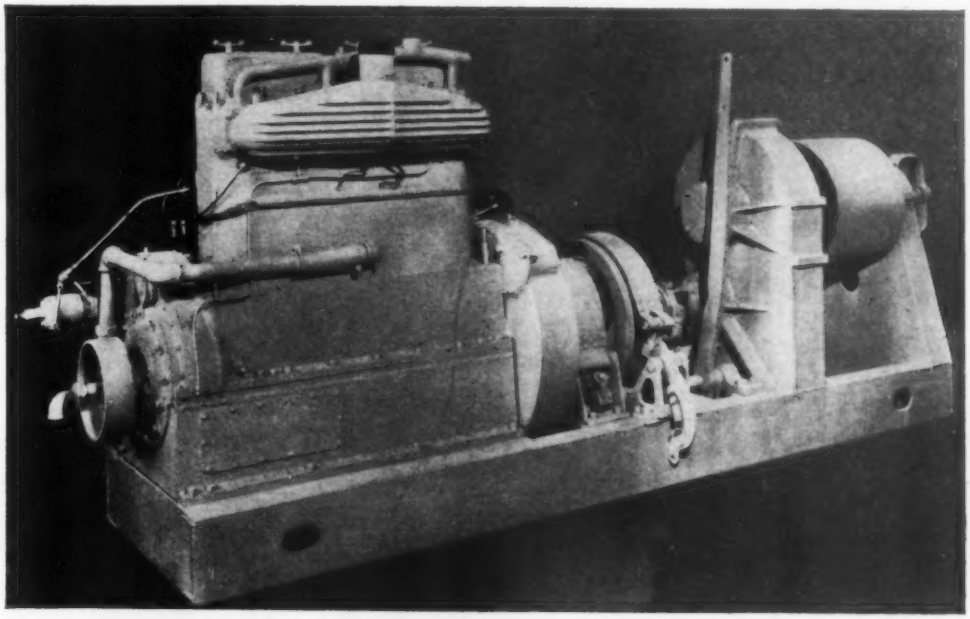
Neglecting to improve equipment, and production, and cost is the surest road to the valley of any business curve.

. . . But for climbing out, and up . . .

"IMPROVEMENT...the key," *he says*

Look, "L. G.," how recourse to Welded Design improves the product and cuts its cost . . . provides the key to a stronger competitive position:

10% LOWER COST



. . . 25% Lighter . . . with Welded Design

Product: Four cylinder gas or gasoline engine, for oil field drilling, designed and manufactured by Buffalo Gasoline Motor Co., Buffalo, N. Y. Changeover to welded design resulted in these improvements:

10% Lower Cost. Saves materials. Eliminates operations. Reduces machining. Saves factory space. Overall savings 10%.

25% Less Weight. Simplifies transportation and installation in rough oil field terrain . . . reduces hauling time and increases drilling time.

Durable. Strong, welded steel construction withstands severe field service. Engines are operating continuously 24 hours per day for periods as long as 60 days.

Faster Changes. Designs can be improved easily, quickly, cheaply with standard materials and existing production equipment.

The Lincoln Engineer nearby will gladly help you improve your products with Welded Design. Machine Design Application Sheets will be mailed you free; ask for them on your letterhead.

THE LINCOLN ELECTRIC COMPANY • DEPT. G-1 • CLEVELAND 1, OHIO

America's greatest natural **recourse**

ARC WELDING

Beetle commands attention!

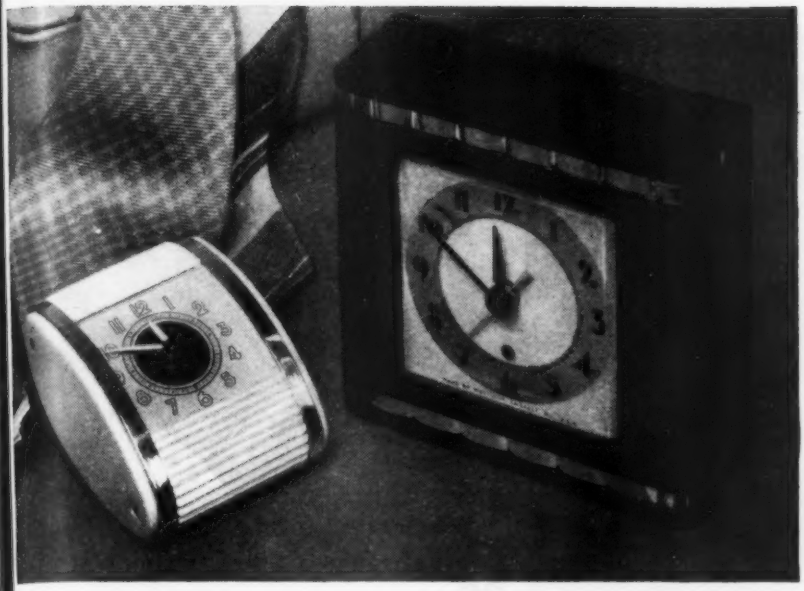
...and rings the cash register, too! Because lustrous BEETLE* colors add eye appeal to any product that calls for more than a second glance...because BEETLE invites the closer inspection that turns casual shoppers into customers on the spot!

BEETLE is an ideal plastic material for many other reasons. Besides the endless range of permanent colors, it has the advantages of dimensional stability, chemical inertness, light weight, resistance to impact, wear, and abrasion. This combination of qualities makes BEETLE a success in a wide range of applications such as lighting, housings, buttons, tableware, and electrical applications.

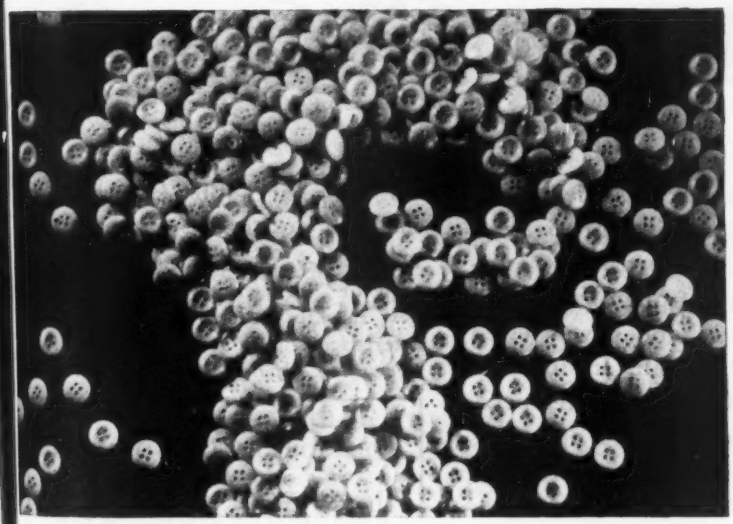
Additional information on BEETLE, the *plastic that's all color in all colors,* is yours for the asking. Your inquiry will receive prompt, experienced attention. **Reg. U. S. Pat. Off.*

LIFE ON THE PLASTICS NEWSFRONT

AMERICAN CYANAMID COMPANY • PLASTICS DIVISION
30 ROCKEFELLER PLAZA • NEW YORK 20, N. Y.



(*Above*) **HOUSINGS FOR CLOCKS,** radios, electric razors, timers, and a variety of other items molded of BEETLE have color appeal, a pleasant feel, and resistance to wear and abrasion that means durability.



(*Above*) **BUTTONS** in white, pearl, ivory, or colors to match materials, can be molded of BEETLE with complete assurance of uniform strength, size, and shape, unvarying color, luster and brilliance.

(*Below*) **IN ELECTRICAL APPLICATIONS** such as these switches made by Micro Switch Corporation to control airplane mechanisms, BEETLE's dimensional stability, dielectric properties, and light weight help assure reliable performance under extreme service conditions. Practical use is also made of BEETLE's color in the housing covers to identify contact arrangement and type of switch.

...as the Ideal Plastic For Many Uses

(*Below*) **FOR LIGHTING, BEETLE's** translucence, its high light transmission, and excellent light diffusing qualities make it ideal for lighting reflectors, such as this BEETLE "Safety" Plastic Reflector in "The 5000 Line" of Markel Electric Products, Inc.

Cyanamid Plastics
Beetle · Melmac · Melurac
Laminac · Urac

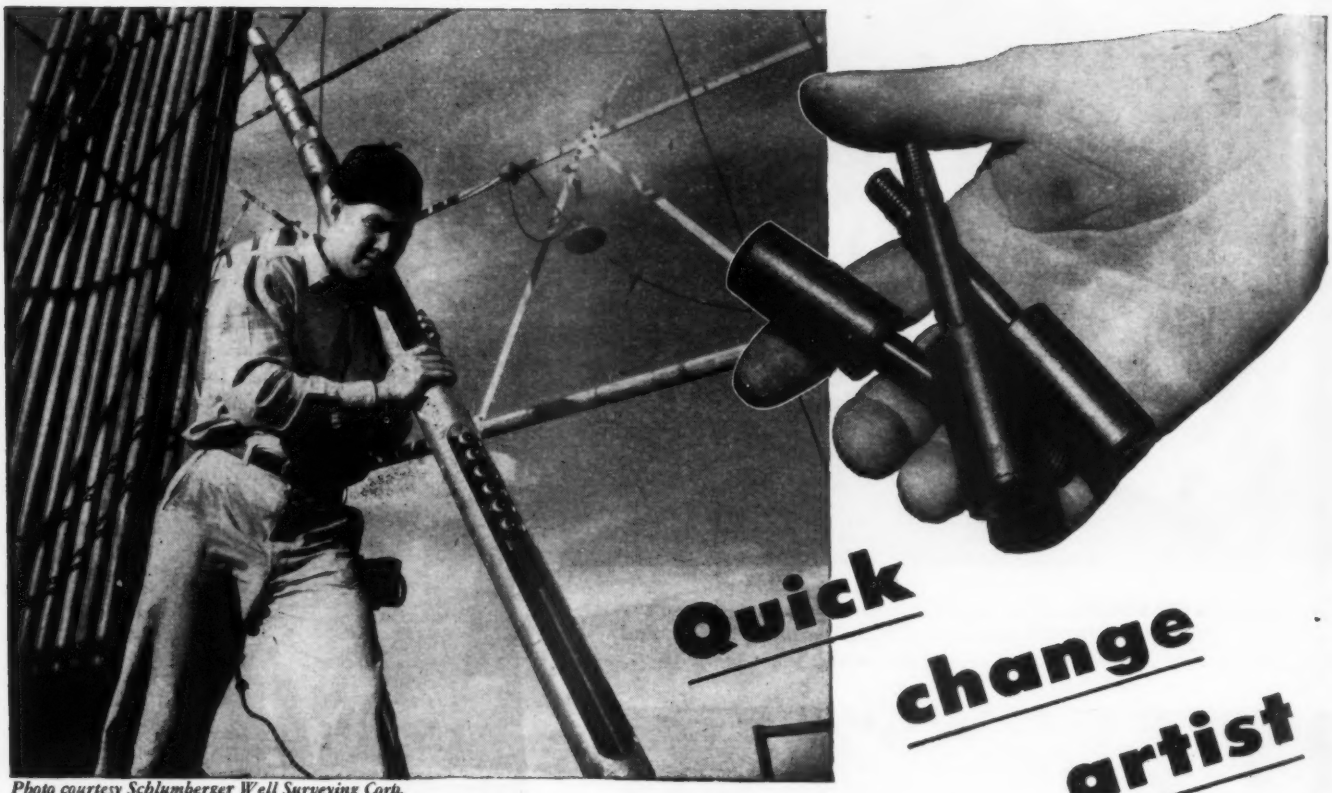


Photo courtesy Schlumberger Well Surveying Corp.

THAT oil well surveyor is a fast worker—thanks to synthetic rubber parts made of Hycar. He uses several different special-purpose pieces of equipment, like the one in the picture, that are lowered into the well to help him get information to direct the drillers. They're all electrically operated, and all work from the same power cable.

It used to be a tedious job to remove the cable from one instrument and attach it to another. Because of this the equipment manufacturer developed a new connector that made the job a matter of minutes. But the first insulation used in this new connector absorbed water and seriously affected the performance of the instrument. Another synthetic was tried, but it had poor insulating properties. Then a special electrically resistant compound of one of the many Hycar synthetic rubbers was tested—and filled the bill. It stood up perfectly under the high temperatures and other severe operating conditions usually encountered in oil wells. The manufacturer then standardized on Hycar parts and his troubles were over.

In the oil fields, in aviation, in *all* industry Hycar synthetic rubbers are constantly finding new applications. Wherever there's a need for a permanently resilient material having any of the properties shown in the box—and in a wide variety of *combinations,* each designed to do a specific job—Hycar is the material to use.

FREE—Write department O-3 for your copy of "Everywhere in Industry", the new booklet describing Hycar's characteristics, with full technical data. *Hycar Chemical Company, Akron 8, Ohio.*

CHECK THESE SUPERIOR FEATURES OF HYCAR

1. *EXTREME OIL RESISTANCE—insuring dimensional stability of parts.*
2. *HIGH TEMPERATURE RESISTANCE—up to 250° F. dry heat; up to 300° F. hot oil.*
3. *ABRASION RESISTANCE—50% greater than natural rubber.*
4. *MINIMUM COLD FLOW—even at elevated temperatures.*
5. *LOW TEMPERATURE FLEXIBILITY—down to —65° F.*
6. *LIGHT WEIGHT—15% to 25% lighter than many other synthetic rubbers.*
7. *AGE RESISTANCE—exceptionally resistant to checking or cracking from oxidation.*
8. *HARDNESS RANGE—compounds can be varied from extremely soft to bone hard.*
9. *NON-ADHERENT TO METAL—compounds will not adhere to metals even after prolonged contact under pressure. (Metal adhesions can be readily obtained when desired.)*

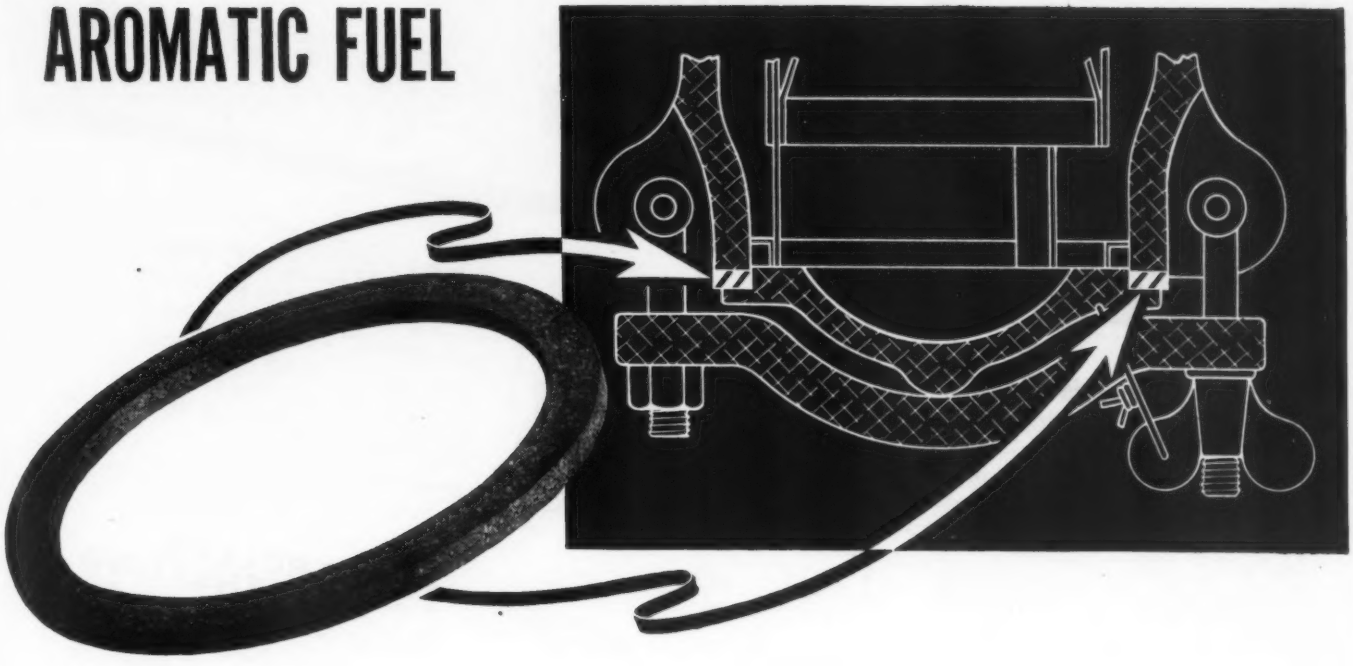
Hycar

Reg. U. S. Pat. Off.

LARGEST PRIVATE PRODUCER OF BUTADIENE TYPE

Synthetic Rubbers

THIS GASKET SEALS AROMATIC FUEL



THE introduction of aromatic aircraft fuel gave manufacturers of gasoline-handling equipment many new sealing problems. Gaskets and packings which were perfectly satisfactory in ordinary gasoline would swell excessively in contact with aromatic blends.

The gasket shown above supplied the answer to this problem. It is made of an Armstrong's Cork-and-Synthetic-Rubber Composition—one of ten sealing materials developed by Armstrong for use with aromatic fuel.

This Armstrong's Gasket is permanently resilient . . . assuring a tight seal. It has little tendency to stick to metal; thus it facilitates removal of parts and stays fit for re-assembly.

Aromatic blend resistant compositions are only one of the many types of sealing materials made by Armstrong for use where temperatures do not exceed 300° F. Others include cork-rubber compositions, cork-and-synthetic rubber compositions, synthetic rubbers, fiber sheet packings, cork compositions, and rag felt papers.

For specifications and application data on these materials, send for your copy of Armstrong's new booklet, "Gaskets, Packings, and Seals." Write, too, for unbiased recommendations on any specific sealing problems you may have. Address Armstrong Cork Company, Gaskets and Packings Department, 7104 Arch Street, Lancaster, Pennsylvania.

MATERIALS AND SPECIALTIES FOR AIRCRAFT AND AUTOMOTIVE UNITS

- **Tank strap cushions**
- **Composition roll goods**—with or without fabric back, plain or adhesive-coated—used as glazing strip, binding tape, cushion pads, and anti-skid flooring.
- **Felts** for vibration-damping and soundproofing
- **Resilient floorings**
- **Carburetor floats** and other fabricated natural or composition cork specialties

ARMSTRONG'S *Gaskets, Packings, and Seals*

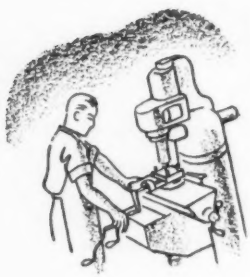
Gibson Springmaking safeguarded at 6 vital stages

1 SOUND DESIGN

Existing specifications checked by qualified engineers in the light of recent developments and improvements. Creative design and experimental work for new mechanisms.

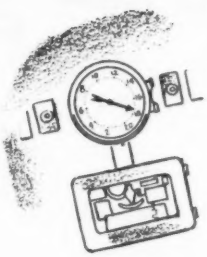
4 EFFICIENT PRODUCTION

Springs assigned to individual department best equipped in tools, machines and manpower for type and volume required. Small orders filled in special department.



2 SKILLED TOOLS

Step-by-step analysis of operations required to produce spring — for combinations of motions necessary, based on intricacy of shape or production volume desired.

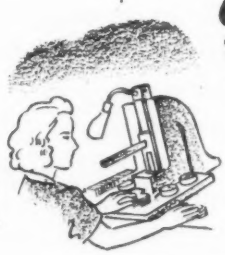


5 CONTROLLED HEAT-TREATING

Fully-automatic continuous furnaces under direct laboratory supervision give accurate, uniform results so important to spring installation and lasting performance.

3 APPROVED MATERIALS

Careful selection and examination of steels and alloys for uniformity and content—stocks graded for stress ranges based on actual tests.



6 SELECTED TESTS

Standard fatigue-testing equipment plus specially designed mechanisms to simulate actual operating conditions—magna flux and stroboscopic equipment.

LET GIBSON ENGINEERS SAFEGUARD *YOUR* SPRING REQUIREMENTS

ARMY E NAVY

GIBSON SPRINGS

The WILLIAM D. GIBSON CO. DIVISION OF ASSOCIATED SPRING CORPORATION

1800 CLYBOURN AVENUE, CHICAGO 14, ILLINOIS

DETERMINING WHEN AND HOW MUCH FOR OXYGEN REGULATORS...*automatically*

Why Hydron Evacuated Bellows Assemblies Respond to Pressure Changes . . . *accurately*

As an airplane climbs, its crew breathes air, air plus oxygen, or pure oxygen . . . depending on the altitude. An oxygen regulator attached to each mask supplies the right air-oxygen mixture. An evacuated bellows assembly — as photographed from three angles above — in each oxygen regulator accurately translates changes in altitude into motion to operate the valves.

Extreme accuracy in the relationship of bellows travel to atmospheric pressure is vital — and spring rate is only as accurate as the wall thickness of the bellows.

Accurate wall thickness is inherent in the hydraulic method of forming bellows . . . *a Clifford production achievement* whereby the walls of cold metal tubes are flowed by internal hydraulic pressure between the plates of a collapsible die. That's why Hydron Evacuated Bellows Assemblies . . . designed, assembled, evacuated, sealed and tested by Clifford . . . are in such great demand for vital oxygen regulators.

CLIFFORD HAS THE FACTS

If your product requires the accurate translation of altitude or vacuum changes into motion . . . as in oxygen regulators or absolute pressure and controlling instruments or other applications listed in the coupon . . . consult Clifford for trouble-saving facts before your designs are too far advanced.

Submit sketches and data for specific recommendations. For an advance sample of Clifford's facts, use the coupon below — today.

CLIFFORD

First with the Facts on Hydraulically-formed Bellows

HYDRON

Feather Weight HYDRON Metal Bellows

Feather-weight . . . the First All-Aluminum Aircraft Oil Coolers and Coolant Radiators . . . Made with Hydron Tubing . . . Brazed by Clifford's Patented Method.

CLIFFORD MANUFACTURING COMPANY
364 E. FIRST STREET, BOSTON 27, MASS.

Please send me information on Hydron Bellows and Bellows Assemblies. I am interested in applying them to the equipment checked.

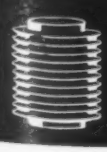
- ☐ Air conditioners - unit
- ☐ Air conditioning systems
- ☐ Aircraft
- ☐ Carburetor altimeter controls
- ☐ Engine thermostats
- ☐ Gasoline valves
- ☐ High pressure steam devices
- ☐ Hot water heaters
- ☐ Instruments
  - Remote and direct control of temperature and pressure
- ☐ Kilns & ovens — industrial
- ☐ Oil heating systems
- ☐ Oxygen flow indicators
- ☐ Oxygen regulators
- ☐ Process controls
- ☐ Refrigerating systems
- ☐ Refrigerator controls
- ☐ Refrigerator switches
- ☐ Stoves & ovens — commercial
- ☐ Stoves & ovens — domestic
- ☐ Supercharger controls

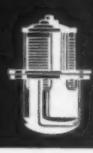
Other applications .....

NAME .....

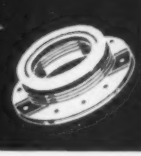
COMPANY .....

ADDRESS .....


INSTRUMENT BELLOWS


AIRCRAFT BELLOWS ASSEMBLY

STEAM TRAP BELLOWS ASSEMBLY

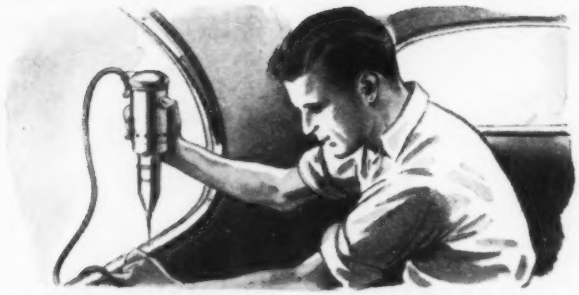

BELLOWS SEAL ASSEMBLY

ALL ALUMINUM OIL COOLER

ALL ALUMINUM COOLANT RADIATOR

EASY ON MEN!

Hand driving screws into garnish molding is slow, hard work. But as long as he used slotted screws, this world-famous manufacturer of automobile bodies didn't dare risk power driving. Driver skids came too high – and too often!



EASY ON THE POCKETBOOK!

A change to Phillips Recessed Head Screws ruled out driver skids . . . permitted use of power methods. Also eliminated one operation involving countersunk washers. All of which added up to substantial cost-savings!

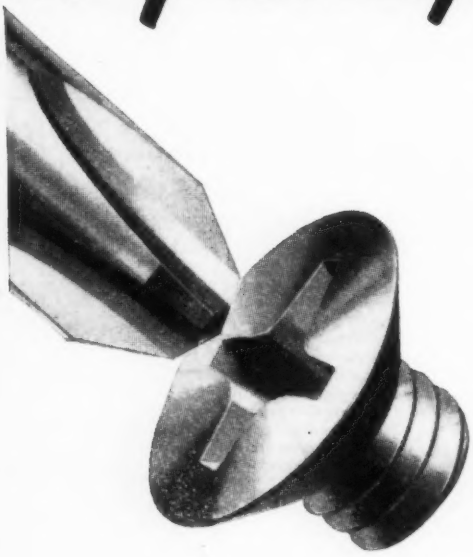
EASY ON ENGINEERING!

Easy on assemblymen . . . easy on the pocketbook . . . Phillips Screws are kind to design staffs, too. With Phillips, engineers can build product strength and rigidity up to specifications slotted screws just can't approach!

EASY ON THE EYES!

Besides being strength-builders, Phillips Screws are also great little sales-builders. They help dress up any product . . . do away with unsightly burrs that snag clothing and make an otherwise sweet piece of merchandise look sour!

It's Phillips — the engineered recess!



In the Phillips Recess, mechanical principles are so correctly applied that every angle, plane, and dimension contributes fully to screw-driving efficiency.

. . . It's the exact pitch of the angles that eliminates driver skids.

. . . It's the engineered design of the 16 planes that makes it easy to apply full turning power – without reaming.

. . . It's the "just-right" depth of recess that enables Phillips Screw Heads to take heaviest driving pressures.

With such precise engineering, is it any wonder that Phillips Screws speed driving as much as 50% – cut costs correspondingly?

To give workers a chance to do their best, give them faster, easier-driving Phillips Recessed Head Screws. Plan Phillips Screws into your product now.

PHILLIPS *Recessed Head* SCREWS

WOOD SCREWS • MACHINE SCREWS • SELF-TAPPING SCREWS • STOVE BOLTS

Made in all sizes, types and head styles

25 SOURCES

American Screw Co., Providence, R. I.
Atlantic Screw Works, Hartford, Conn.
The Bristol Co., Waterbury, Conn.
Central Screw Co., Chicago, Ill.
Chandler Products Corp., Cleveland, Ohio
Continental Screw Co., New Bedford, Mass.
The Corbin Screw Corp., New Britain, Conn.
General Screw Mfg. Co., Chicago, Ill.
The H. M. Harper Co., Chicago, Ill.
International Screw Co., Detroit, Mich.
The Lamson & Sessions Co., Cleveland, Ohio
Manufacturers Screw Products, Chicago, Ill.
Milford Rivet and Machine Co., Milford, Conn.
The National Screw & Mfg. Co., Cleveland, Ohio
New England Screw Co., Keene, N. H.
Parker-Kalon Corp., New York, N. Y.
Pawtucket Screw Co., Pawtucket, R. I.
Pheoll Manufacturing Co., Chicago, Ill.
Reading Screw Co., Norristown, Pa.
Russell Burdsall & Ward Bolt & Nut Co., Port Chester, N.Y.
Scovill Manufacturing Co., Waterville, Conn.
Shakeproof Inc., Chicago, Ill.
The Southington Hardware Mfg. Co., Southington, Conn.
The Steel Company of Canada Ltd., Hamilton, Canada
Wolverine Bolt Co., Detroit, Mich.

"I want a SPRING that won't . . .

. . . rust in a steam iron."

. . . get tired in a shaver."

. . ruin the taste of coffee."

. . . burn out in a toaster."

TEMPERATURE RANGE . . . SPECIALIZED PROPERTIES OF CORROSION-AND-HEAT-RESISTANT INCO NICKEL ALLOY SPRINGS

UP TO 400° F. —AT MODERATE STRESSES
Pure Nickel springs offer good electrical conductivity . . . good magnetic permeability.

UP TO 400° F. —AT MODERATE STRESSES
Monel springs are slightly magnetic . . . lowest in price of the corrosion-resistant INCO Nickel Alloys.

UP TO 500° F. —AT FAIRLY HIGH STRESSES
"K" Monel springs are non-magnetic, heat-treatable.

UP TO 500° F. —AT HIGH STRESSES
"Z" Nickel springs provide fairly good electrical conductivity . . . good magnetic permeability . . . are heat-treatable.

UP TO 700° F. —AT HIGH STRESSES
Inconel springs are essentially non-magnetic . . . combine corrosion resistance with strength at high temperatures.

A "tremendous trifle," the tiny spring in a toaster, steam iron, or a shaver has importance far beyond its size.

When the spring fails, the whole appliance usually quits. And that means disgruntled buyers, all the way along the line back to the maker.

Spring failure, however, is something you don't have to put up with.

You've undoubtedly heard how well the INCO Nickel Alloys serve in *big* jobs where high temperatures and corrosive conditions must be licked.

Did you know they do the same outstanding job in *small* applications?

For instance, in steam-iron, flat-iron and waffle-iron thermostats . . . where corrosion is a constant threat . . . Inconel springs serve at temperatures that range from 500° to 700° F. In toasters, Inconel springs assure reliable "pop up," despite high temperatures.

Monel springs in coffee makers resist corrosion . . . protect true coffee flavor. "Z" Nickel has the high fatigue resistance needed where continuous flexing is encountered, as in dry shavers.

Further information about the properties of INCO Nickel Alloy springs is given in the technical bulletin, "New Spring Alloys for Tough Jobs." And INCO technical service is always available for consultation on specific metal problems. Address:

THE INTERNATIONAL NICKEL COMPANY, INC., 67 Wall Street, New York 5, N. Y.

MAIL THIS COUPON NOW

THE INTERNATIONAL NICKEL COMPANY, INC.
67 Wall Street, New York 5, N. Y.

Please send me a copy of the INCO Technical Bulletin, "New Spring Alloys for Tough Jobs."

Name.....

Title.....

P.E. 4-45

Company.....

Address.....

NICKEL INCO ALLOYS

MONEL · "K" MONEL · "S" MONEL · "R" MONEL
"KR" MONEL · INCONEL · "Z" NICKEL · NICKEL
Sheet . . Strip . . Rod . . Tubing . . Wire . . Castings . . Welding Rods (Gas & Electric)

NO. 3 IN A SERIES EXPLAINING HOW ELECTRONIC TUBES CAN BE USED TO IMPROVE EQUIPMENT DESIGN

The famed bazooka is one of today's light, strong products welded with current controlled by G-E IGNITRONS

For resistance welding, G-E ignitron tubes are fast, precise, quiet, and need minimum maintenance

WHEN you are designing welding equipment, consider strongly the merits of G-E ignitron tubes for current-control purposes. These powerful, steel-jacketed electronic tubes perform a dual function. They open and close the welding machine primary circuit with split-second precision; they also control current-flow as required by the job on hand.

● **Their operation** is instantaneous, noiseless, and involves no rotating or moving parts of any kind. Maintenance therefore is at the minimum—no lubrication and no wear that requires adjustment—facts which reflect themselves in lower upkeep cost and superior dependability.

● **By all means** investigate the application of G-E ignitrons to welding apparatus now being designed or being considered for installation in your plant.

● **General Electric** will be glad to cooperate with you in this study. Also, a copy of the illustrated, informative book on "How Electronic Tubes Work" is yours for the asking. Telephone your nearest G-E office or distributor, or write today for details. *Electronics Department, General Electric, Schenectady 5, N. Y.*

TYPE GL-415
PRICE $30.

A steel-jacketed 3-electrode ignitron tube with mercury-pool cathode, for welder-control service. Cathode has special splash-ring baffle. Rugged, compact — only 5¼" long, 2¾" diameter—and easily installed. Water-cooled by a clamp for that purpose, which also locates and mounts the tube. Ratings are maximum kva demand 300, with corresponding average anode current 12.1 amp—maximum average anode current 22.4 amp, with corresponding kva demand 100. (These ratings for voltages of 600 rms and below.) Ignitor requirements 200 v and 30 amp.

Type GL-415 also operates for certain types of welder-control service with forced-air cooling. Special ratings on request.

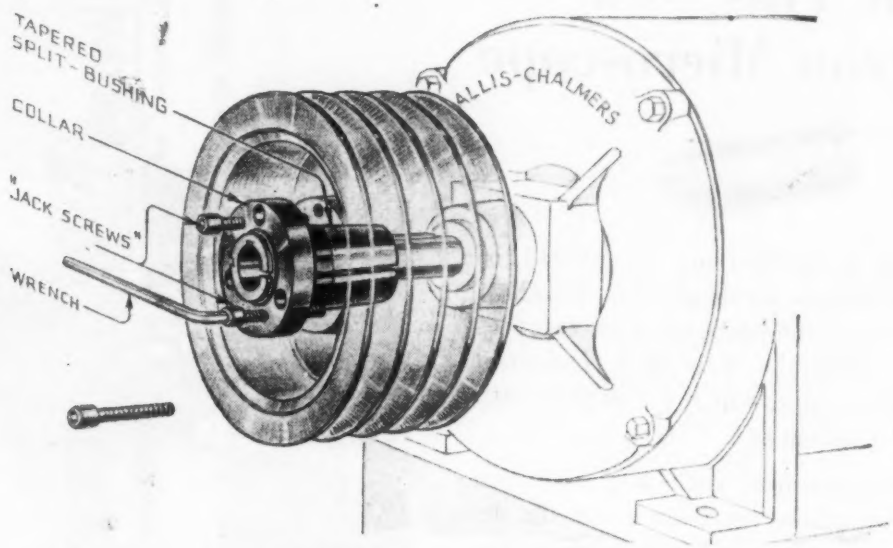
Hear the G-E radio programs: *"The World Today" news, Monday through Friday, 6:45 p. m., EWT, CBS. "The G-E All-Girl Orchestra," Sunday 10 p. m., EWT, NBC. "The G-E House Party," Monday through Friday, 4 p. m., EWT, CBS.*

G. E. HAS MADE MORE BASIC ELECTRONIC-TUBE DEVELOPMENTS THAN ANY OTHER MANUFACTURER

GENERAL ELECTRIC

X-Ray View

OF ALLIS-CHALMERS' NEW "MAGIC-GRIP" SHEAVE



Fastest mounting and demounting sheave on the market, the new "Magic-Grip" costs you nothing extra.

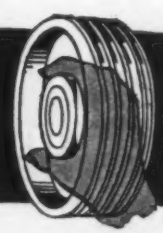
1 **Remove three capscrews** from bushing collar. A handy wrench — supplied with each sheave — is the only tool needed to remove Allis-Chalmers' new "Magic-Grip" from motor or machine shaft quickly and easily.

2 **Insert two capscrews** in tapped holes. As screws are turned, they become levers . . . automatically breaking tight grip of tapered split bushing on sheave and shaft. Entire unit is then ready for removal.

3 **Remove sheave from shaft.** Requires no mallet, no prying, no bulging muscles. You just slide the sheave off . . . smoothly, quickly. *It costs nothing extra!* Send for B6310. Allis-Chalmers, Milwaukee 1, Wis.

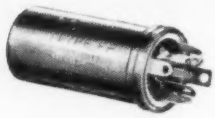
A 1770

Allis-Chalmers Texrope

"MAGIC-GRIP"  **SHEAVES**

MALLORY FP CAPACITORS

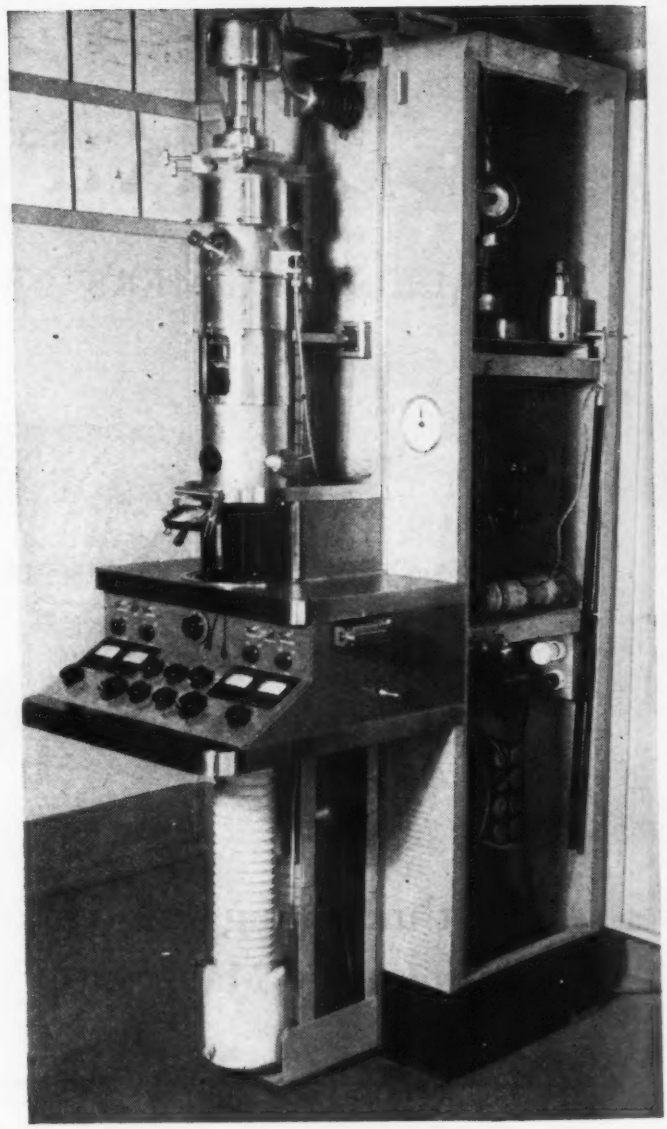
Brighten the "Eye" of This New Electron Microscope



USEFUL magnification in excess of 100,000 times (or diameters), as against 3,000 times with the best optical microscopes is possible with the new RCA Universal Electron Microscope, which is equipped with Mallory FP Capacitors.

A precision instrument such as the electron microscope requires precision parts. In designing the power supply for this new microscope, RCA engineers specified Mallory FP Capacitors in several standard capacities, to assure better definition for the microscope—a brighter "eye". Thoroughly dependable, noted for their long life, these precision-built capacitors are the smallest available for a given electrical rating . . . permitting more compact circuit designs.

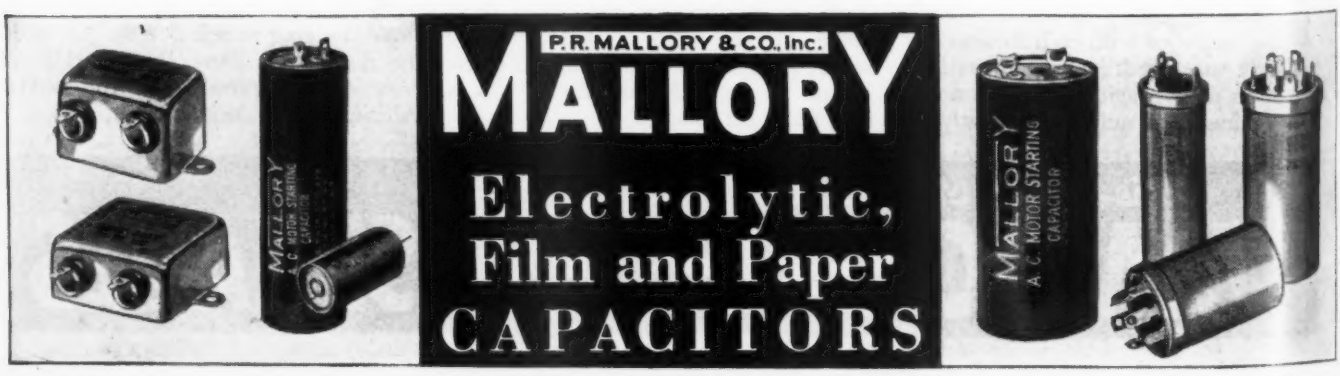
Mallory FP Capacitors are furnished in ratings from 10 mfd. to 3,000 mfd. at operating voltages from 10 volts (3,000 mfd.) to 450 volts. Self-contained mounting features assure quick assembly. Extra "hardware" is eliminated because of the patented twisted-ear mounting feature.



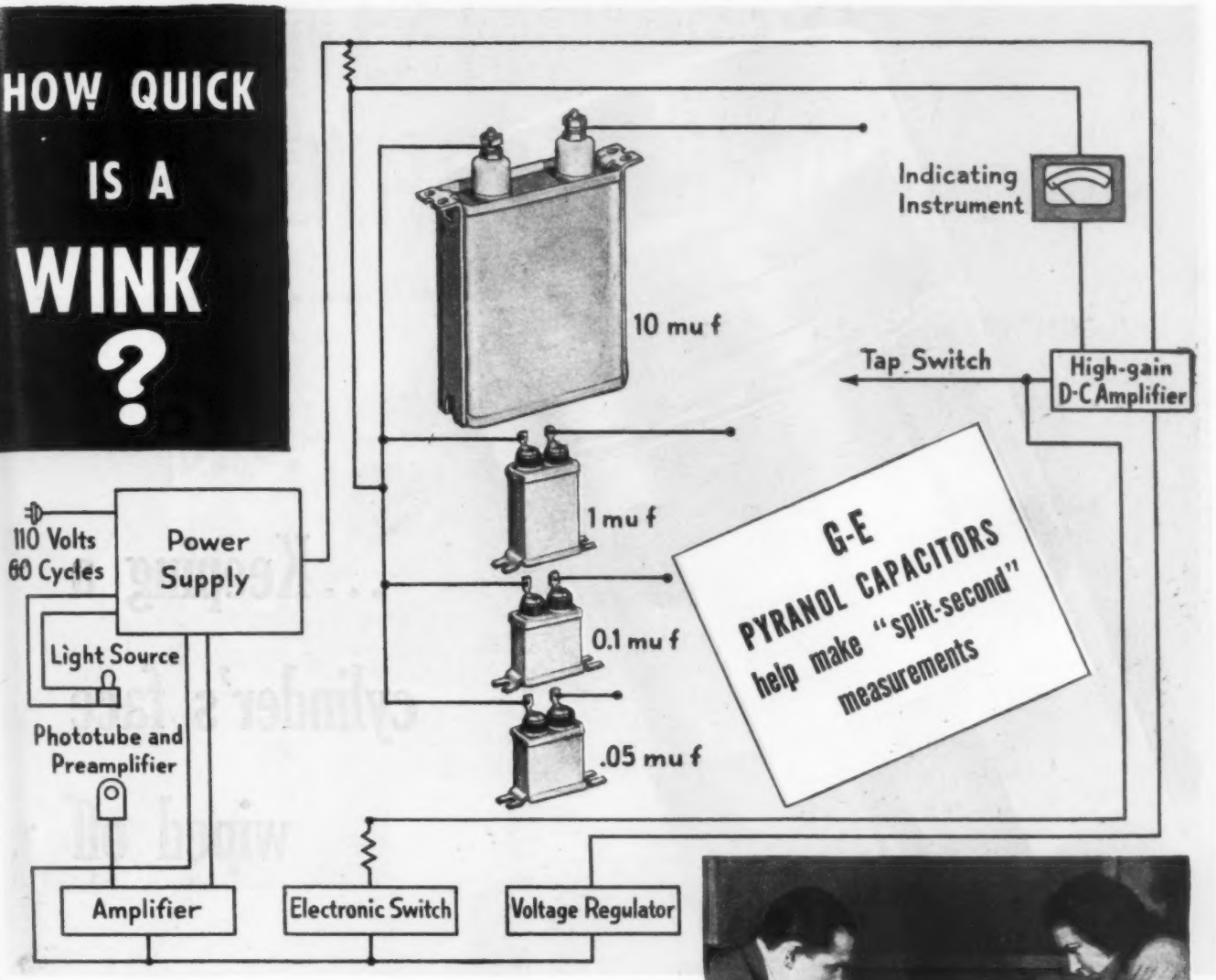
This new RCA Universal Electron Microscope is equipped with Mallory FP Capacitors in several standard capacities.

Ask your nearest Mallory Distributor for a copy of the Mallory catalog, containing full information on capacitors and other precision parts for electronic and electrical equipment. Or write us today.

P. R. MALLORY & CO., Inc., INDIANAPOLIS 6, INDIANA



HOW QUICK IS A WINK ?



Another new job for capacitors

WHILE we have not yet measured the quickness of a wink with the time-interval meter, we know that it will do more practical jobs like measuring the time required for a camera shutter to open, or the time that it remains open. This meter is also being used to synchronize flash-bulb contacts on camera shutters, test relay performance, and measure the velocity of moving bodies.

Here's how Pyranol* capacitors are used in its circuit: An external contact or a phototube, working through the amplifier, causes the electronic switch to close during the time period to be measured. While the electronic switch is closed, one of the Pyranol capacitors is charged at a constant rate through a precision resistor. Thus, the voltage developed across the Pyranol capacitor is a direct measure of the required time interval.

Four Pyranol capacitors and several charging resistors are used to obtain eight full-scale ranges (0.001, 0.003, 0.01, 0.03, 0.1, 0.3, 1, and 3 seconds). A tap switch on the instrument panel is used to select the correct Pyranol capacitor and resistor for the desired scale range.

An inverse feed-back arrangement holds the charging rate constant while the Pyranol capacitor is charging, and also corrects for leakage in several elements. The feed-back principle also enables the use of a direct indicating instrument to measure the capacitor charge, without discharging the capacitor.

The way Pyranol capacitors are used in this circuit may suggest a better way to do some job in one of your circuits. Remember that the high capacitance per cubic inch of Pyranol capacitors, their compact, space-saving shapes, and long life make them ideal for a wide variety of built-in applications.

This sensitive electronic instrument accurately measures time intervals as short as 1/10,000 second. It is being used here to measure the time the man takes to react and turn off the lamp after it has been turned on by the girl. (Reaction time on this test: 175–200 milliseconds.)

Booklets on our various lines—h-f paper dielectric, h-f parallel plate, Lectrofilm, as well as Pyranol units—are yours for the asking. General Electric, Schenectady 5, N. Y.

*Trade-mark Reg. U.S. Pat. Off.

GENERAL ELECTRIC

407-85-5706

BUY WAR BONDS

...Keeping a cylinder's face wiped off

TOO *much* oil inside a cylinder means wasteful burning with each explosion. Too *little* results in friction between rings and cylinder wall.

So, piston ring manufacturers developed an oil ring in *3 segments*—one thick, open ventilated ring between two extremely *thin* rings. Result—*3* wiping edges, and a wiping action that adjusted itself more perfectly to the contour of the cylinder.

Developing the right kind of *steel* to extremely close tolerances for those thin outer rings was a special problem.

It had to be *heat resistant* to withstand the temperatures inside a cylinder without warping... *tough* enough to stand up in that very *thin* form without cracking... *highly resilient* to conform to the shape of a worn cylinder without being permanently distorted.

That's why we at Athenia had a hand in making the steel which would meet those exacting requirements... why we take special pride in the satisfactory performance these rings are now delivering.

If you have a precision steel problem involving stocks 1/16" to 6½" wide, .0015" to .062" thick, annealed, cold rolled, tempered, or tempered polished and colored, let Athenia's 30 years' experience help *you*.

NS
The ATHENIA STEEL Company
DIVISION OF NATIONAL-STANDARD

★ BUY AND KEEP WAR BONDS

Divisions of National-Standard Company

THE ATHENIA STEEL CO.
Clifton, N. J.
COLD ROLLED, HIGH-CARBON SPRING STEEL

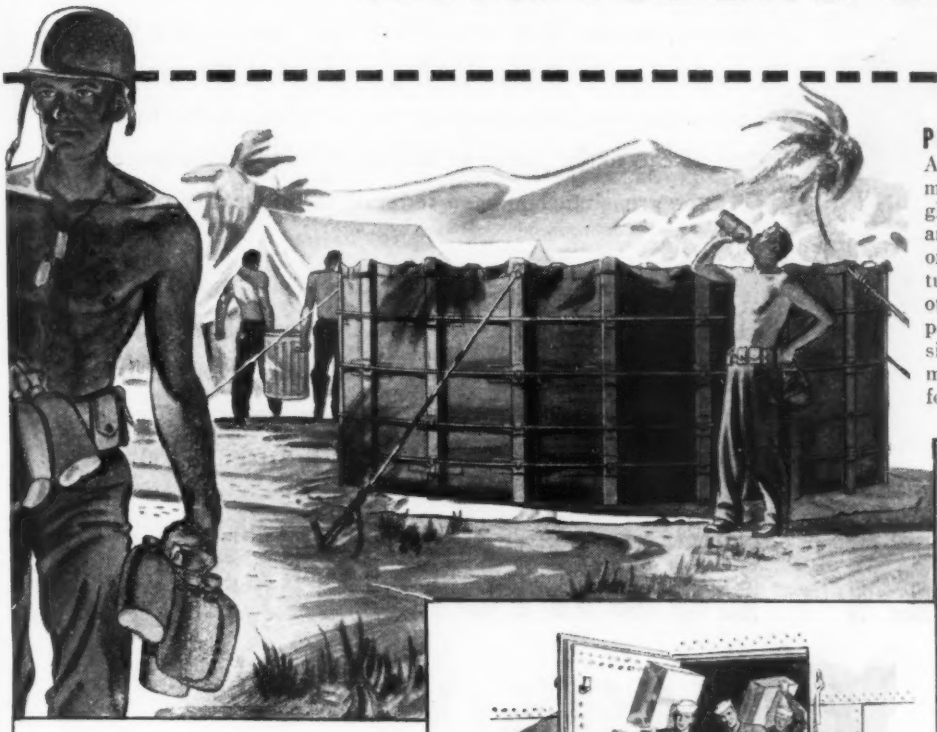
NATIONAL-STANDARD CO.
Niles, Mich.
TIRE WIRE, FABRICATED BRAIDS AND TAPE

WORCESTER WIRE WORKS
Worcester, Mass.
ROUND STEEL WIRE, SMALL SIZES

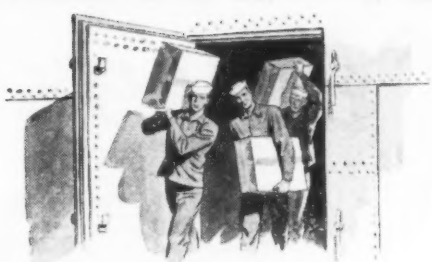
WAGNER LITHO MACHINERY CO.
Hoboken, N. J.
LITHOGRAPHING AND SPECIAL MACHINERY

WHAT NEXT..

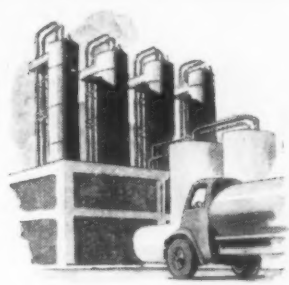
WILL THEY DO WITH FIBERS OF GLASS?



PORTABLE WATER TANKS, used by our Armed Forces in the Pacific theater, are made of *Coated Fiberglas* Cloth*—an all-glass fabric coated with synthetic rubbers and other compounds. Being *glass* and inorganic, Fiberglas Cloth is resistant to moisture, the action of mold and fungus growths, other causes of rot and decay. It also possesses great tensile strength and dimensional stability. These and other properties make Fiberglas Cloth an ideal base fabric for various coatings.



COLD STORAGE ROOMS aboard ship — as in warehouses, locker plants, other establishments ashore—are efficient and economical to operate when insulated with *Fiberglas Thermal Insulating Materials.* In addition to having very low heat conductivity, Fiberglas offers all the advantages of an *inorganic* material. This lightweight insulation resists moisture, is odorless and absorbs no odors, and affords no sustenance for vermin.



HIGH-PROOF ALCOHOL for the synthetic rubber program . . . 100-octane gasoline for our fighter planes . . . other chemical products critically needed for the war effort . . . are being produced faster or more economically due to *Fiberglas Tower Packing.* Light in weight and possessed of *both* great surface area and large free volume, Fiberglas has brought new efficiency to distillation, fractionation, many other chemical and process operations.

IN HARD-HITTING B-29's, the Army's long-range, high-altitude bombers, *Fiberglas Aircraft Insulation* is adding to the comfort and efficiency of crewmen. Made of fine fibers of glass interlaced in soft, fleecy blankets, Fiberglas provides efficient acoustical and thermal insulation. And it is so light that 20 sq. ft. (one-inch thick) weigh less than a pound. Because it is incombustible and highly moisture-resistant, inorganic Fiberglas *retains* its insulating efficiency.

Buy War Bonds .. for Keeps!

● In practically every phase of the war effort, Fiberglas is helping American industry do many jobs better, faster, more economically. Industrial engineers and designers have already found thousands of applications for Fiberglas products and new uses are being constantly developed.

For more information regarding this versatile material and its applications, write *Owens-Corning Fiberglas Corp., 1807 Nicholas Bldg., Toledo 1, Ohio. In Canada, Fiberglas Canada Ltd., Oshawa, Ontario.*

FIBERGLAS

* T. M. Reg. U. S. Pat. Off.

PRELUBRICATED SEALED BALL BEARINGS...NOW STANDARD ON TYPE CSP MOTORS UP TO 3 HP

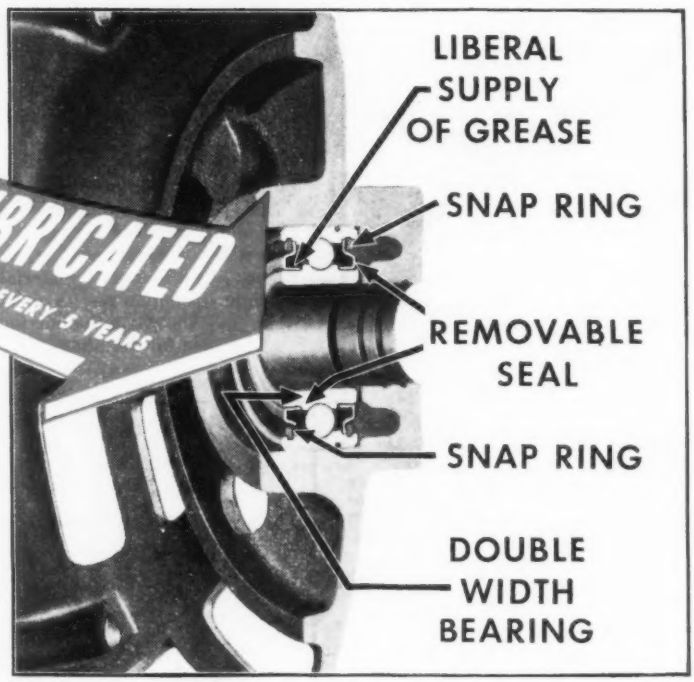
Bought now, Westinghouse Type CSP Prelubricated Motors need no greasing till 1950! Extensively field tested in thousands of textile motor applications, the prelubricated ball bearings in Westinghouse Type CSP general-purpose motors have proved they can operate five years . . . 24 hours a day . . . without greasing. Overgreasing and consequent grease seepage into windings is eliminated. One of the major items of induction motor maintenance, periodic greasing, has been reduced to one grease packing job in five years.

Every Westinghouse Type CSP Motor up to 3 hp carries the "Prelubricated" label. For complete information on how the Type CSP Motor can reduce your maintenance, write for D.B. 3100-CSP. Westinghouse Electric & Manufacturing Co., P.O. Box 868, Pittsburgh 30, Pa.

J-21317

FORGET LUBRICATION...

till 1950!



ADVANTAGES OF WESTINGHOUSE TYPE CSP PRELUBRICATED MOTORS

- **Prelubricated Sealed Ball Bearings** reduce lubrication maintenance . . . assure longer grease life
- **Improved Tuffernell Insulation**
- **Dynamically Balanced Rotor**
- **Die-cast Rotor** with oversize fan
- **Liberal Through-ventilation**—air enters front, leaves at drive end of motor

Westinghouse

PLANTS IN 25 CITIES . . . OFFICES EVERYWHERE

Type CSP Motors

What LANGUAGE would you like to teach your machines ?

You can teach your machine to talk in any language that will convey useful production news to its users. You can make it report its own performance in any terms or units listed on the blackboard above . . . or however else required. For there is some type of compact Veeder-Root Counting Device (with simple drive-connections for mechanical or electrical operation) that can be built into your machine as an integral part, without basically changing your design. And you will find that this *added usefulness* is a potent news-feature that can be merchandised as on the tag below . . . proof positive to your customers that you have gone all the way in helping them to get out of your machines all the performance that you built into them.

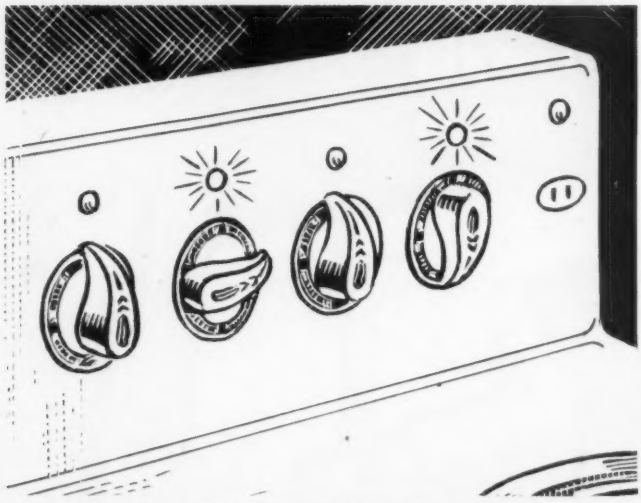
VEEDER-ROOT INC.
Hartford 2, Conn.

WE'D LIKE TO HELP YOU BRING UP YOUR BABY!

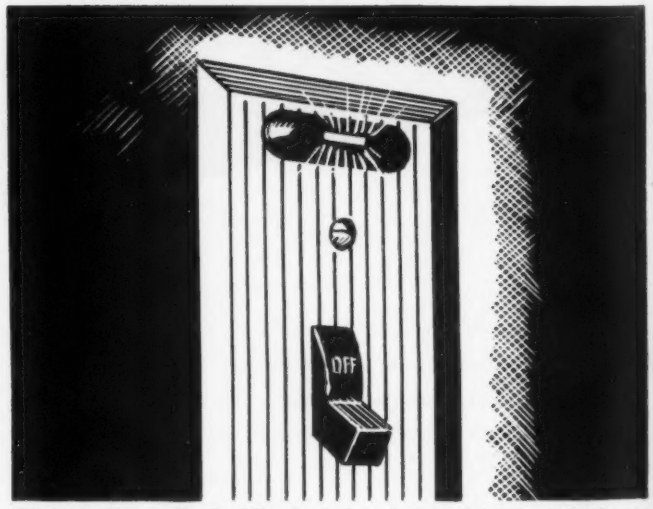
• Got a postwar baby on the drafting boards? Want to add to its sales appeal? The unique characteristics of General Electric Glow Lamps as quick visual indicators recommend them for hundreds of handy uses on appliances, wiring devices and electrical equipment.

Consider These Advantages!

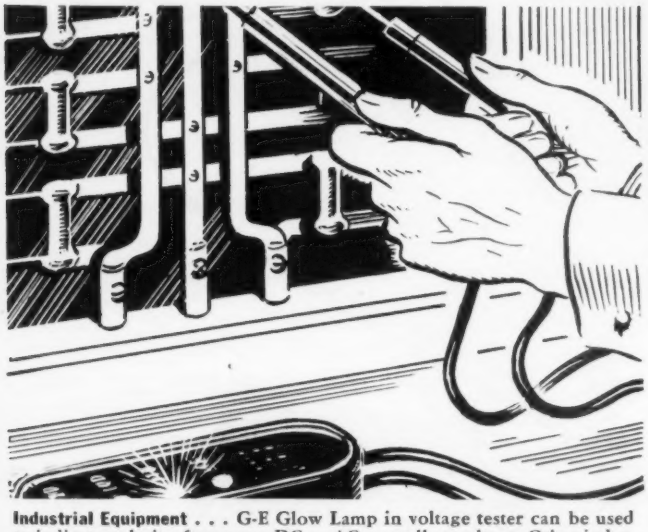
1. **Distinctive orange red glow, needs no cover glass.**
2. **Dependable long life—rated at 3,000 hours.**
3. **Very low current consumption.**
4. **Variety of sizes and wattages.**
5. **High resistance to vibration and shock.**
6. **Usable on AC or DC circuits.**
7. **Work on regular 105-125 volt circuits without the use of step-down transformers.**
8. **Practically no heat.**



Home Appliances . . . Build more usefulness into your appliances. G-E Glow Lamp gives instant visual indication that range units are on. Other applications: waffle irons, electric irons, roasters, heating pads, etc.



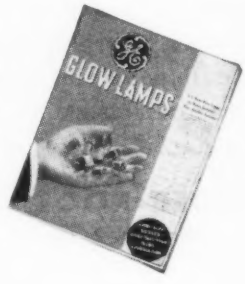
Wiring Devices . . . No fumbling in dark to find the light switch if it has a G-E Glow Lamp as an indicator. When lights are off, the glow lamp is a highly visible indicator as to location of the light switch.



Industrial Equipment . . . G-E Glow Lamp in voltage tester can be used to indicate polarity, frequency, DC or AC, as well as voltage. Other industrial uses: indicators for exits, fire alarm stations, panelboards.

FREE! NEW BOOKLET!

Write to the address below for the useful new folder "G-E Glow Lamps," describing typical uses and listing essential lamp data. Experienced G-E Lamp Engineers will be glad to advise you!



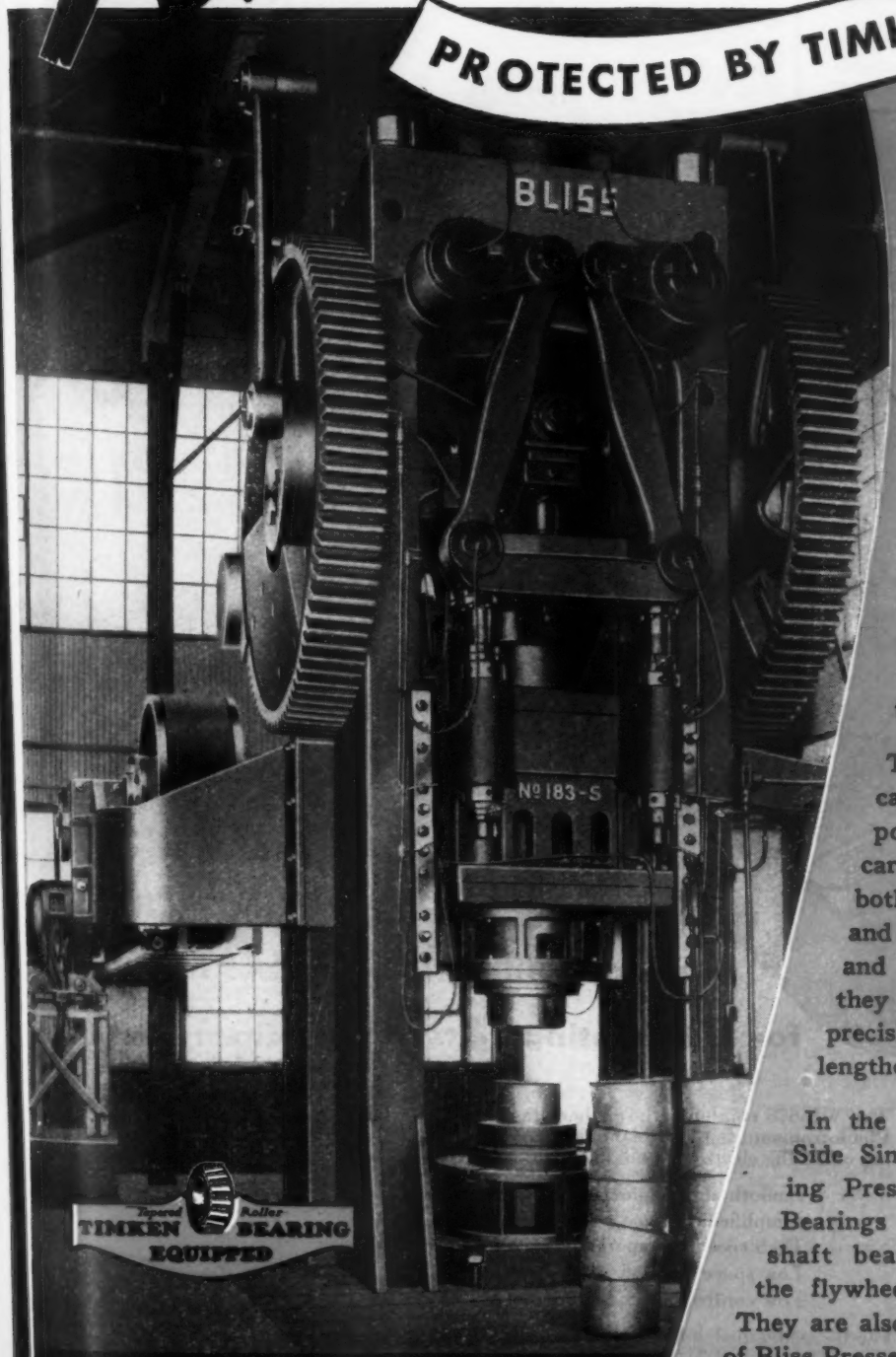
NELA SPECIALTY DIVISION LAMP DEPARTMENT

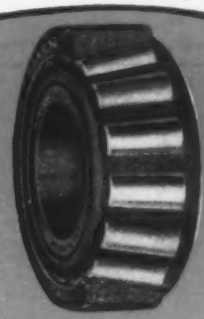
GENERAL ELECTRIC

1 Newark St., Hoboken, N. J.

Power for the deep draw

PROTECTED BY TIMKEN BEARINGS





There's no percentage in using more power than is necessary to do the job in any kind of machine. Recognizing this, thousands of equipment manufacturers use Timken Tapered Roller Bearings to economize power by preventing loss through friction.

They use Timken Bearings because, in addition to saving power, these bearings safely carry all loads—radial, thrust, or both together in any combination; and hold moving parts in correct and constant alignment. Thus they help to increase operating precision; add endurance; and lengthen machine life.

In the No. 183-S Bliss Straight Side Single Crank Toggle Drawing Press pictured here, Timken Bearings are applied at all driveshaft bearing positions and in the flywheel — 8 bearings in all. They are also used in other models of Bliss Presses; have been for years. The E. W. Bliss Company has proved they pay—and so have their customers. Quality is assured when the trademark "TIMKEN" appears on every bearing. The Timken Roller Bearing Company, Canton 6, Ohio.

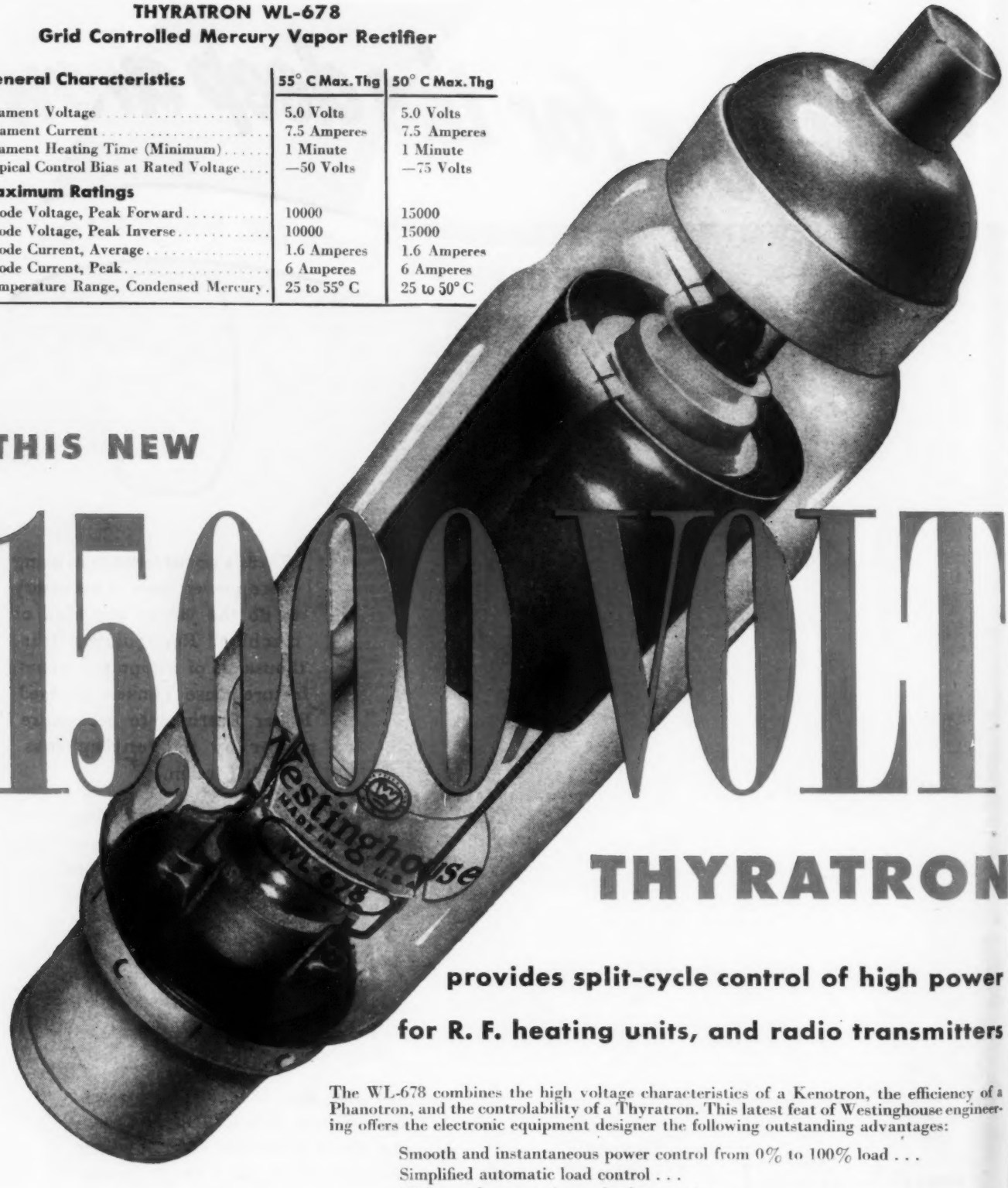
TIMKEN

TRADE-MARK REG. U. S. PAT. OFF.

TAPERED ROLLER BEARINGS

THYRATRON WL-678
Grid Controlled Mercury Vapor Rectifier

General Characteristics	55° C Max. Thg	50° C Max. Thg
Filament Voltage	5.0 Volts	5.0 Volts
Filament Current	7.5 Amperes	7.5 Amperes
Filament Heating Time (Minimum)	1 Minute	1 Minute
Typical Control Bias at Rated Voltage	—50 Volts	—75 Volts
Maximum Ratings		
Anode Voltage, Peak Forward	10000	15000
Anode Voltage, Peak Inverse	10000	15000
Anode Current, Average	1.6 Amperes	1.6 Amperes
Anode Current, Peak	6 Amperes	6 Amperes
Temperature Range, Condensed Mercury	25 to 55° C	25 to 50° C



THIS NEW 15,000 VOLT THYRATRON

provides split-cycle control of high power for R. F. heating units, and radio transmitters

The WL-678 combines the high voltage characteristics of a Kenotron, the efficiency of a Phanotron, and the controlability of a Thyratron. This latest feat of Westinghouse engineering offers the electronic equipment designer the following outstanding advantages:

Smooth and instantaneous power control from 0% to 100% load . . .
Simplified automatic load control . . .
High speed automatic overload protection . . .
Low space and weight requirements . . .
Low control power requirements . . .

For more detailed information—write to your nearest Westinghouse office or to Westinghouse Electric and Manufacturing Company, Lamp Division, Bloomfield, N. J. Westinghouse Electronic Tube distributors are located in principal cities.

Westinghouse
PLANTS IN 25 CITIES OFFICES EVERYWHERE
Quality Controlled Electronic Tubes

FUZON-O

The New Waterproof Coating with "VINYLITE" Resin base

CUTS TIME, LABOR & MATERIALS, IN HALF

FUZON-O, the amazing new "Vinylite" resin base formulation which cuts cost three ways, resists oil, grease, alkali and acid . . . withstands the oxidizing effects of air and the photochemical effect of sunlight . . . is exceptionally immune to moisture, abrasion and temperature variations. Use FUZON-O on cotton, nylon and glass fabrics . . . and many other materials. For complete information about FUZON-O address the Stanley Chemical Company . . . manufacturers of Stanley Lacquers, Enamels, Synthetics and Japans . . . East Berlin, Connecticut.

*Trade Mark Carbide and Carbon Chemicals Corporation

Stanley Chemical

"Nothing ever put so much

NEW LIFE in this shop . . .

. . . as these Quick and Easy-Driving AMERICAN PHILLIPS SCREWS"

Yes, it always boosts the morale of workers when they're freed from the slow, exhausting, dangerous work of hand-driving slotted screws . . . and switched onto the fast, effortless, safe method of power-driving American Phillips Screws.

Output jumps to new highs. Accidents and rejects hit bottom. *Total time-savings climb as high as 50%.* For American Phillips Screws banish the fear of mistakes, instil new self-confidence, build pride in good work. In fact, good work is the *only kind* that *can* be done, with American Phillips Screws. The recessed head stays straight on the 4-winged driver 'till the screw is turned up tight and flush. And this surety of operation means fairer return on fixed overhead . . . an advantage no shop, large or small, can afford to miss.

To these advantages are added other exclusive American advantages . . . the capacity of one of the largest U. S. screw plants . . . 3-point inspection that checks every screw-head, thread, and point . . : and the ready advice, on any fastening job, of American's veteran corps of engineers.

AMERICAN SCREW COMPANY, PROVIDENCE 1, RHODE ISLAND
CHICAGO 11: 589 E. Illinois Street **DETROIT 2: 502 Stephenson Building**

Take a Recess from Slotted-Screw Costs and Troubles

. . . the Tapered, Engineered Recess of:

AMERICAN PHILLIPS Screws

PATENTS MAKE JOBS

Put the Screws on the Japs . . .
BUY BONDS!

TOUGH STUFF FOR ROUGH STUFF

"HEY, CUT IT OUT! Don't throw that water!" . . . Rough stuff in the rumpus room has frayed many a parent's nerves. But thanks to VINYLITE plastics, there's upholstery today that stays unfrayed through countless riots—and even keeps on *looking new!*

Tough stuff, this VINYLITE plastic upholstery! It wears as upholstery never wore before. Old age doesn't crack it. Grease can't affect it. You never have to worry about its soiling, for it is readily cleaned with a damp, soapy cloth. In short, upholstery fabric coated with VINYLITE plastic compound brings degrees of wear resistance, long life, and untroubled service never before attained. And it's a *quality* material, at home among the choicest textiles and the most discriminating surroundings. It can be produced in desired colors, in unusual surface effects, and with the rich texture of fine leathers.

Today, VINYLITE plastic upholstery is demonstrating its outstanding wear and toughness in jeeps, planes and tanks. In days to come it will take its place as the superlative material for home and office furniture, motor cars and motor boats, buses, and other peacetime applications.

Specify VINYLITE plastic upholstery for essential uses *now*. Write Department **10** for technical assistance and detailed information.

BAKELITE CORPORATION
Unit of
Union Carbide and Carbon Corporation
UCC
30 EAST 42ND STREET, NEW YORK 17, N.Y.

Vinylite Plastics

TRADE-MARK

The high speed—1,000 R.P.M.—high pressure—1,000 lbs. sq. in. pump built by The F. E. Myers & Bro. Co., Ashland, Ohio is equipped with:

Hyatt Hy-Load Bearings on pinion shaft and crank shaft—Hyatt Wound Roller Bearings (without races) on hardened and ground eccentric shafts

In designing the new Myers Orchard Sprayers, the engineers selected Hyatt Roller Bearings, not only for their precision and long-lived sturdiness but also, for their compactness, which permitted the packing of great power within a minimum of gear space.

This is another example of Hyatt ability to provide bearings that meet exactly the machine designer's requirements. Hyatt engineers stand ready at any time to help you solve specific bearings problems.

HYATT BEARINGS DIVISION—GENERAL MOTORS CORPORATION
Harrison, New Jersey

NEED SOME LARGE SPRINGS NOW?

Coiling equipment forms bars up to 2½" diameter

LARGE SIZE springs can now be supplied at a speed that will "perk up" your production schedules. Extensive manufacturing facilities at Muehlhausen are responsible, where one entire plant is devoted to hot-coiled springs.

Besides quick, quantity delivery, you get two other important advantages from this hot-coil specialization: Design of your springs by Muehlhausen engineers to best meet operating conditions; extra spring life gained by "production lab" control of all processes.

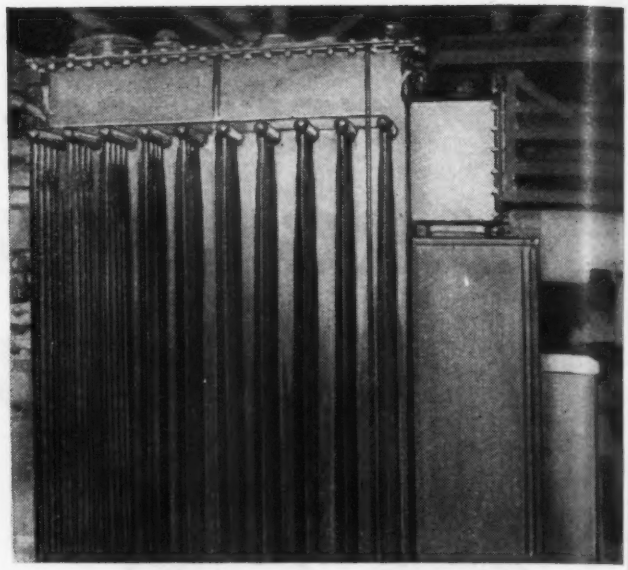
See how these springs are made—SEND FOR NEW ILLUSTRATED FOLDER ON HOT-COILING SPRINGS.

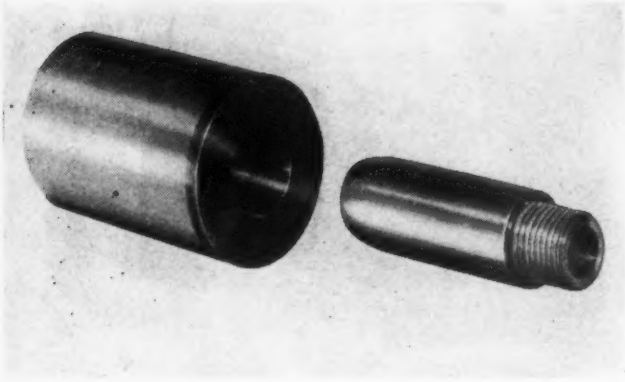
MUEHLHAUSEN SPRING CORPORATION
Division of Standard Steel Spring Company
810 Michigan Avenue, Logansport, Indiana

To improve product performance, use

MUEHLHAUSEN Designed SPRINGS

MALLORY
Heavy-Duty
CONTACTS
Carry 3,000 Amperes at 15,000 Volts





THOUSANDS of Mallory Contacts are giving dependable performance and long life in oil and air circuit breakers for heavy power applications. The heavy-duty contacts illustrated are required to interrupt and carry 3,000 amperes at 15,000 volts, in a giant oil circuit breaker. To meet these requirements calls for contacts that are plenty rugged!

A "plug-and-socket" type of contact assembly is used. To carry the heavy current, contact surfaces of Elkonite* 3W3, a Mallory refractory metal composition, have been specified on the recommendation of experienced Mallory contact engineers. The plug is made of copper with a complete cover of Elkonite on the contacting surface. The socket is also made of copper, with an insert of Elkonite at the contact point. In the actual installation, the socket is cut into several segments, each mounted on a spring.

Mallory engineering "know-how" for solving contact problems covers the range from these large circuit breaker applications to the most minute silver or tungsten contacts for small relays, electronic and automotive controls.

Consult Mallory while your electronic or electrical product designs are being blueprinted. It pays to come to Mallory—Contact Headquarters—for experienced engineering help, the widest selection of contact and contact backing materials, and the most complete manufacturing facilities in the industry.

Write today for your copy of the Mallory contact catalog. The New Mallory Contact Data Book will be sent gratis to engineers when requested on company letterhead. Available to students, libraries and schools at $2.50 per copy, postage paid.

P. R. MALLORY & CO., Inc., INDIANAPOLIS 6, INDIANA

TYPICAL PHYSICAL PROPERTIES OF ELKONITE 3W3

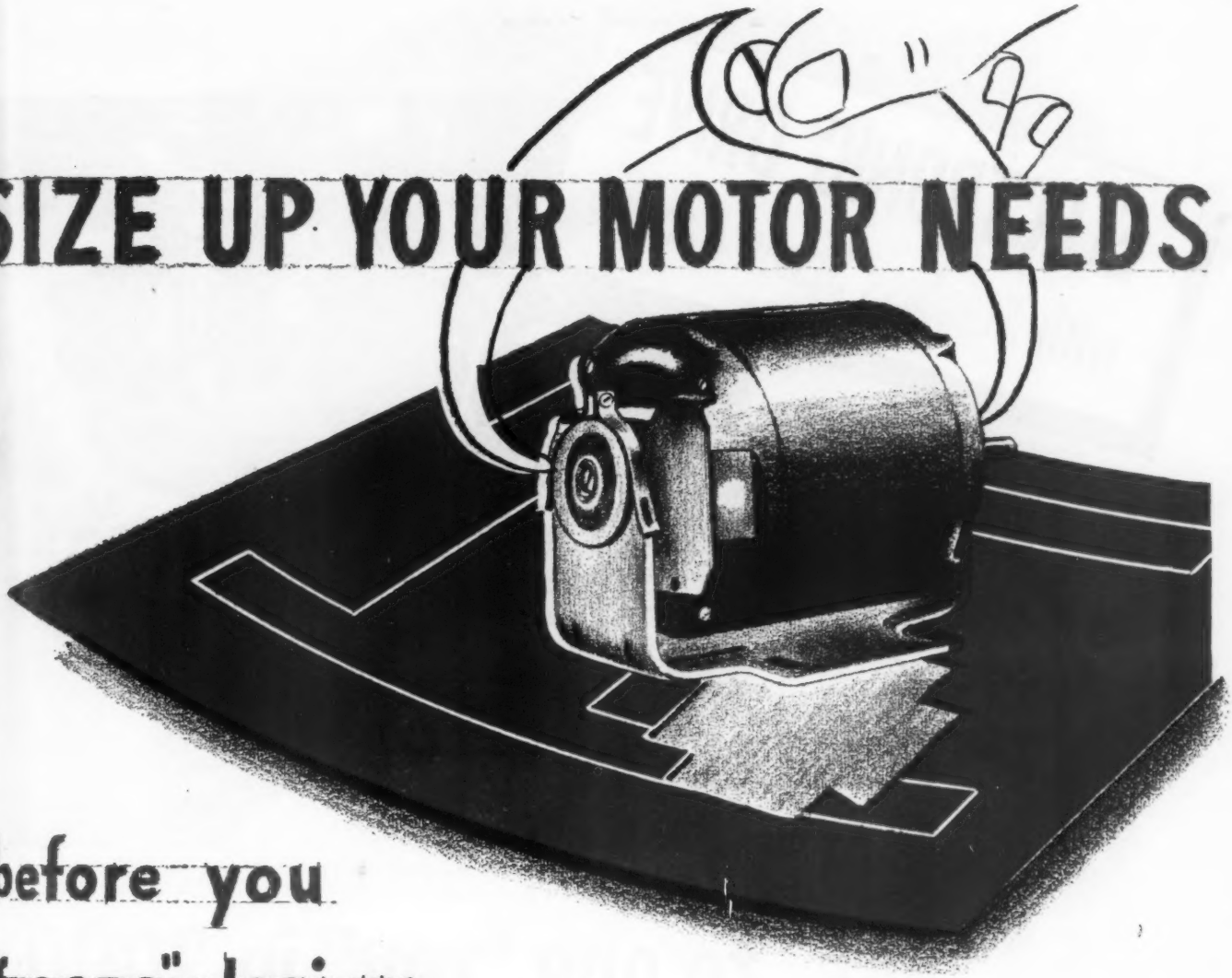
Density: gm.–cc.	13.6
lbs.–cu.in.	.49
Conductivity, % I.A.C.S.	30-35
Hardness, Rockwell B	85-92
Tensile Strength, psi	80,000
Cross Breaking Strength, psi	130,000

Other grades of Elkonite are available with properties adapted to practically all heavy-duty contact applications.

Reg. U.S. Pat. Off. for electric contacting elements.

ELECTRICAL CONTACTS AND CONTACT ASSEMBLIES

SIZE UP YOUR MOTOR NEEDS



before you "freeze" design . . .

ASK A WESTINGHOUSE APPLICATION ENGINEER TO HELP

After the design is "frozen" and your apparatus is tooled, changes to accommodate the motor may be costly and time-consuming. Make certain you select the right motor before you go ahead with design. Make sure, too, that you use existing motor designs wherever possible, and avoid the extra cost of specially-engineered motors.

Standardized designs offer a number of advantages: lower cost, faster deliveries, reduced inventories and simplified servicing.

Westinghouse engineers have been applying fractional horsepower motors for decades, and have built into standard motors many special features to meet particular service requirements. Before you "freeze" design, ask for Westinghouse engineering help. Call your Westinghouse office or write Westinghouse Electric & Manufacturing Co., Lima, Ohio. J-03227

MOTOR EXCHANGE PLAN PROVIDES

REPLACEMENT SERVICE IN 24 HOURS OR LESS

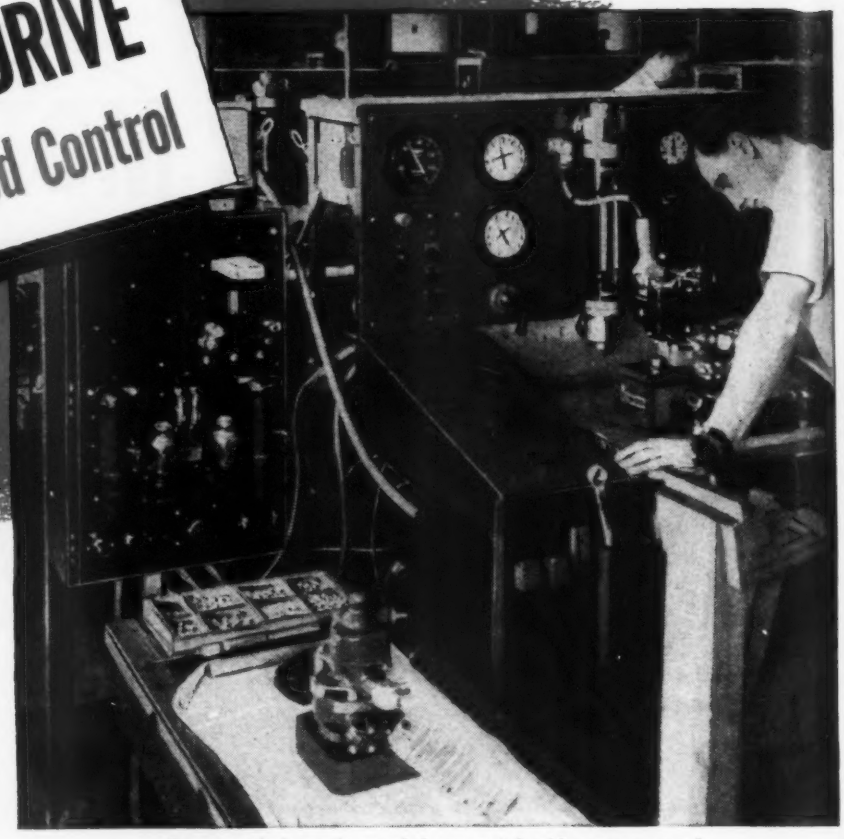
ANYWHERE IN THE UNITED STATES

Westinghouse Motor Exchange points in all principal cities can service most Westinghouse small motors of standard sizes in 24 hours, or less, anywhere in the United States. This service gives the appliance user an efficient, factory-rebuilt replacement motor in exchange for his old motor at a low, flat cost. Your nearest Westinghouse office will give you full details. Ask for bulletin B-3336.

Westinghouse

SMALL MOTOR DIVISION

ELECTRONIC DRIVE with Stepless Speed Control



Thy-mo-trol electronic panel shown at left with cover removed

HELPS CHECK

RPM to one "rev" in 3000

To test pitch-adjusting propeller governors to an accuracy within 1 rpm at maximum speed, Nash-Kelvinator Corporation needed second-splitting test stands far more precise than any conventional type available. Furthermore, the testers had to provide for measurement throughout the full range of rpm over which the governors were to operate.

In designing a new precision unit for the job, Nash-Kelvinator engineers required a motor drive which 1.) had the ability to maintain closely the required operating speed, 2.) provided wide speed range, and 3.) had a simple means of rapidly adjusting speed as desired. G-E Thy-mo-trol drive met all of these requirements.

Operated from a regular a-c power line, Thy-mo-trol furnishes smooth d-c motor torque to drive the governor at the desired speeds. The governor, in turn, controls a hydraulic system which simulates the pitch-adjusting mechanism of the propeller. The Thy-mo-trol drive is a "stand-in" for the propeller system. The Thy-mo-trol control circuit is tied into the hydraulic system so as to permit changing governor speed to duplicate the response of the propeller system, and thus provide a ground test of the governor.

Thy-mo-trol drive offers unusual advantages to designers of highly advanced machines, whether they be testers, machine tools, or special production devices, such as coil winders and welders. A single co-ordinated set of equipment furnishes *fully controllable* d-c motor torque from an a-c supply. Constant-current acceleration and constant speed under varying loads are inherent in the Thy-mo-trol system.

Standard Thy-mo-trol drives, including d-c motor, electronic panel, transformer, and control station, are available from ⅛ to 25 hp. G-E engineers will help you select and apply Thy-mo-trol drives or explore their suitability for new types of jobs. Ask for Bulletin GEA-4025. *General Electric Company, Schenectady 5, N. Y.*

GENERAL ELECTRIC

676-175-8900

Buy all the BONDS you can—and keep all you buy

THY-MO-TROL DRIVE

Stamping this carbine trigger housing from COLD ROLLED STRIP

★Saved 720,000 hours machine time ★Saved 635 tons of steel

★ **Saved $5,100,000 in cost** *(on the basis of producing two million pieces)*

THE conversion of this one part of the U.S. M-1 Cal. 30 Carbine, from a steel forging to copper-brazed strip steel stampings saved *more* than these substantial amounts of time, materials and money. It also released 97 milling machines, 16 broaching machines and 21 profilers for the production of other badly needed ordnance parts.

The production in strip steel of this trigger housing is typical of the important work of redesign and conversion being done by Ordnance engineers and leaders of the pressed metal industry. Some 800 conversion suggestions like this already put into actual production have resulted in savings of enormous amounts of critical materials, have released countless numbers of critical machines, have saved millions of man-hours, saved millions of dollars as well.

The ready adaptability of cold rolled strip steel to this far from simple part—in which final tolerances were maintained to within .002" and .005"—and the savings in weight and cost it makes possible are, we believe, significant to every manufacturer who is looking ahead for ways to improve his peacetime product and to reduce its cost.

We have in our files the records of many such war-time applications of American Quality Cold Rolled Strip that not only indicate the wide field for postwar applications this versatile metal offers but that show, by actual time and cost saved in fabrication, the economic advantages of its use.

Our engineers will gladly discuss this matter in detail with you at your convenience.

AMERICAN STEEL & WIRE COMPANY

Cleveland, Chicago and New York

Columbia Steel Company, San Francisco, *Pacific Coast Distributors*
United States Steel Export Company, New York

USS AMERICAN *Quality* COLD ROLLED STRIP

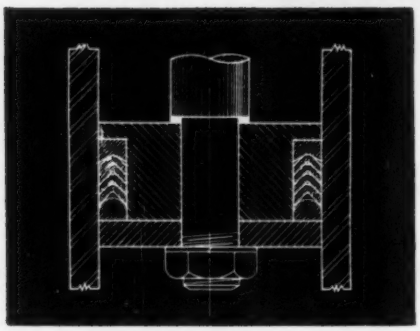
UNITED STATES STEEL

GRATON & KNIGHT ENGINEERS PRESENT

PACKINGS POINTERS No. 11

Handy, file-size folders of each article in the series, including additional information, are available, free. Write to Packings Department, 321 Franklin St., Graton & Knight Company, Worcester 4, Mass.

Methods of Packing Piston Heads



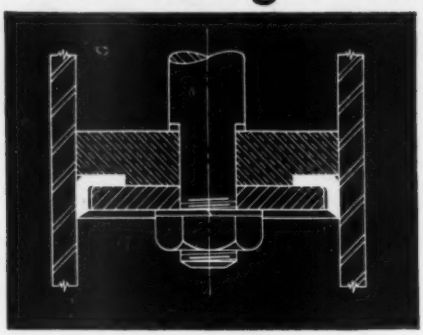
VEE PACKINGS (Fig. 1)

Their characteristics:

A completely mechanical seal
Are effective at high or low pressures
Will give the best service
Will have the longest life
Are somewhat more difficult to install than other types
Can be spring-loaded — very desirable in some applications
Recess requires more machining than for either a U or flange packing.

Select for:

Reciprocating or rotating application
Wide range of pressures
Long, trouble-free service
Minimum of shutdowns during work cycle.



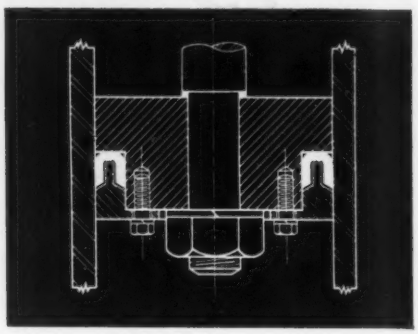
CUP PACKING (Fig. 2)

Its characteristics:

Is easily installed against piston head or backing plate, with follower plate inside cup
No machining of recess is required
Is compression-sealed on bottom of cup
Performs satisfactorily under either low or high pressure
Has excellent service life
Can be easily fitted with any of several types of expanders.

Select for:

Wide range of applications
Low first cost
Fast assembly
Simple accessories
Excellent service life.



U PACKING (Fig. 3)

Its characteristics:

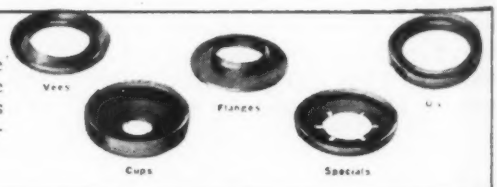
Under pressure a completely mechanical seal is established
Requires only a simple, square recess with chamfer to lead on packing easily
Pedestal ring is recommended, with slight pinch on bottom of packing
Easy to install
Easy to replace
Service life equal to that of cup packing
Higher first cost than cup packing.

Select for:

The U packing is seldom used as a piston head packing, except by personal preference.

SPARTAN LEATHER PACKINGS

Graton & Knight's SPARTAN has highest resistance to abrasion and heat (withstands boil test), is unaffected by common pressure mediums, and will not dry out hard and brittle. It also has exceptional tear and tensile strength. When your design reaches the "packings point" — or when packings trouble occurs — call on G&K engineers.

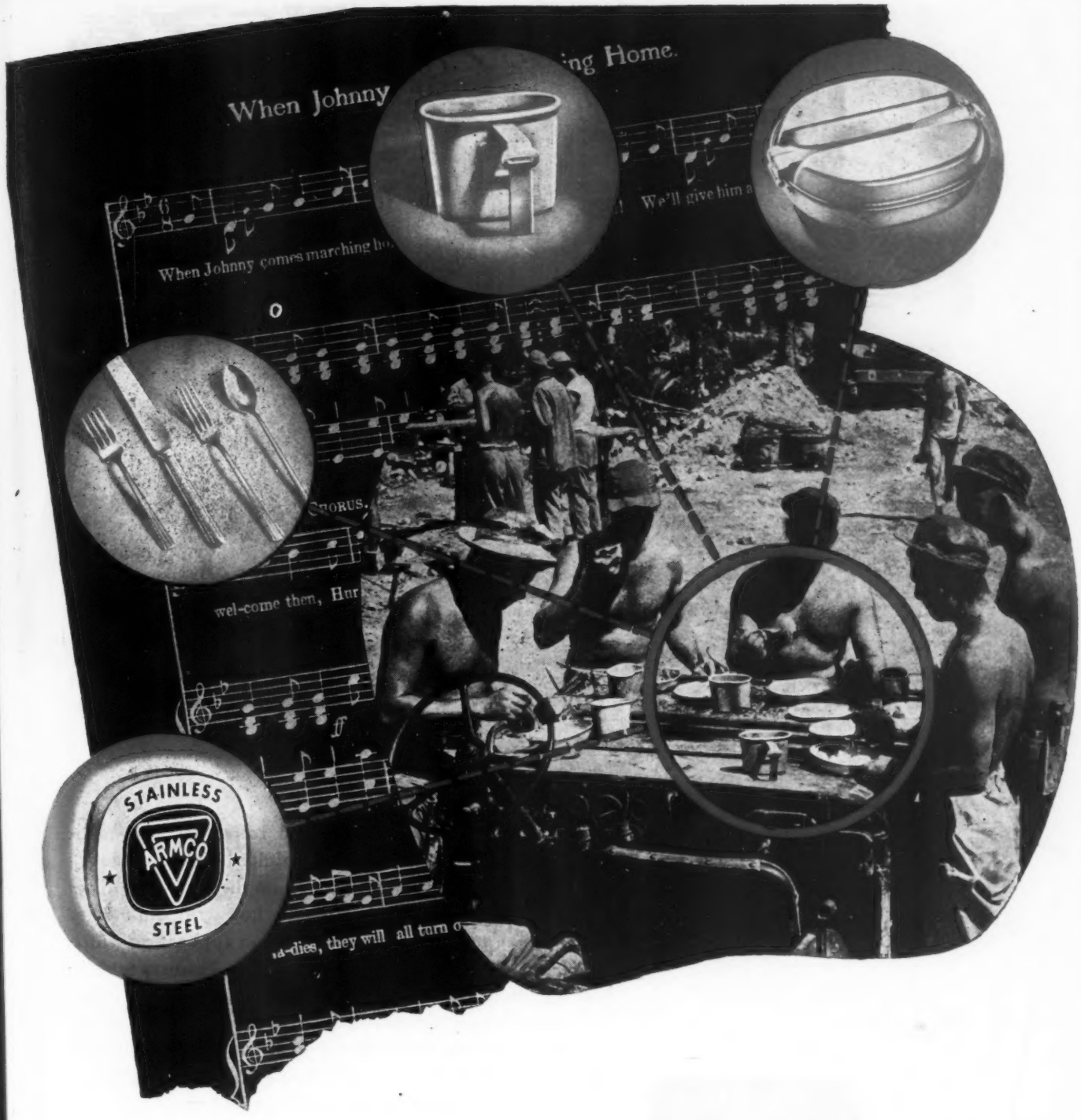


See Graton & Knight Insert in SWEET's File for Product Designers

GRATON AND KNIGHT

SPARTAN ENGINEERED PACKINGS

Leather and synthetic rubber packings manufactured and engineered by the world's largest manufacturer of industrial leather products



IT'LL BE A BRIGHT DAY FOR STAINLESS TOO

When ten million veterans come marching home, many of them will know a lot about the advantages of stainless steel. They'll be "sold" on the merits of this bright rustless metal.

One reason is that the Services give their men the best for eating equipment. ARMCO Stainless Steel is used in mess equipment because it is so easy to keep clean and sterile. Possessing great strength, it can be fabricated into light-weight utensils, so important on a march. And this hard rustless steel is highly resistant to denting, scratching and corrosive conditions.

These advantages of ARMCO Stainless can add distinction and durability to many peacetime products—make them more salable and therefore more profitable. Consider it for your products. Let us talk with your designers so they will have complete information on the various types of ARMCO Stainless Steels and their qualities.

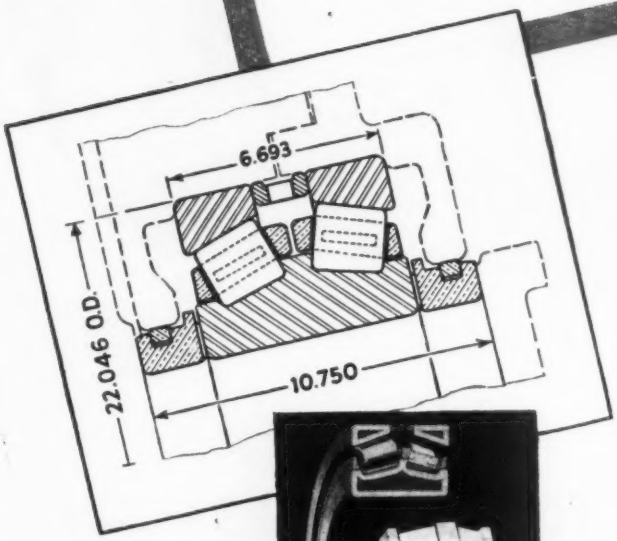
For data on these steels address The American Rolling Mill Co., 1011 Curtis Street, Middletown, Ohio.

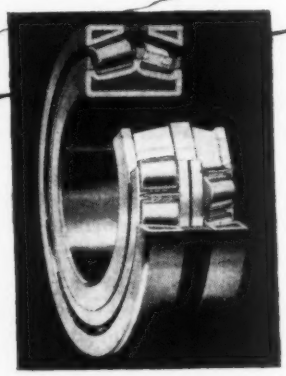
EXPORT: THE ARMCO INTERNATIONAL CORPORATION

The American Rolling Mill Company

BEST FOR BACK-UP ROLLS

CHROME NICKEL STEEL ROLL NECK BEARINGS
HELP SET PEAK TONNAGE RECORDS





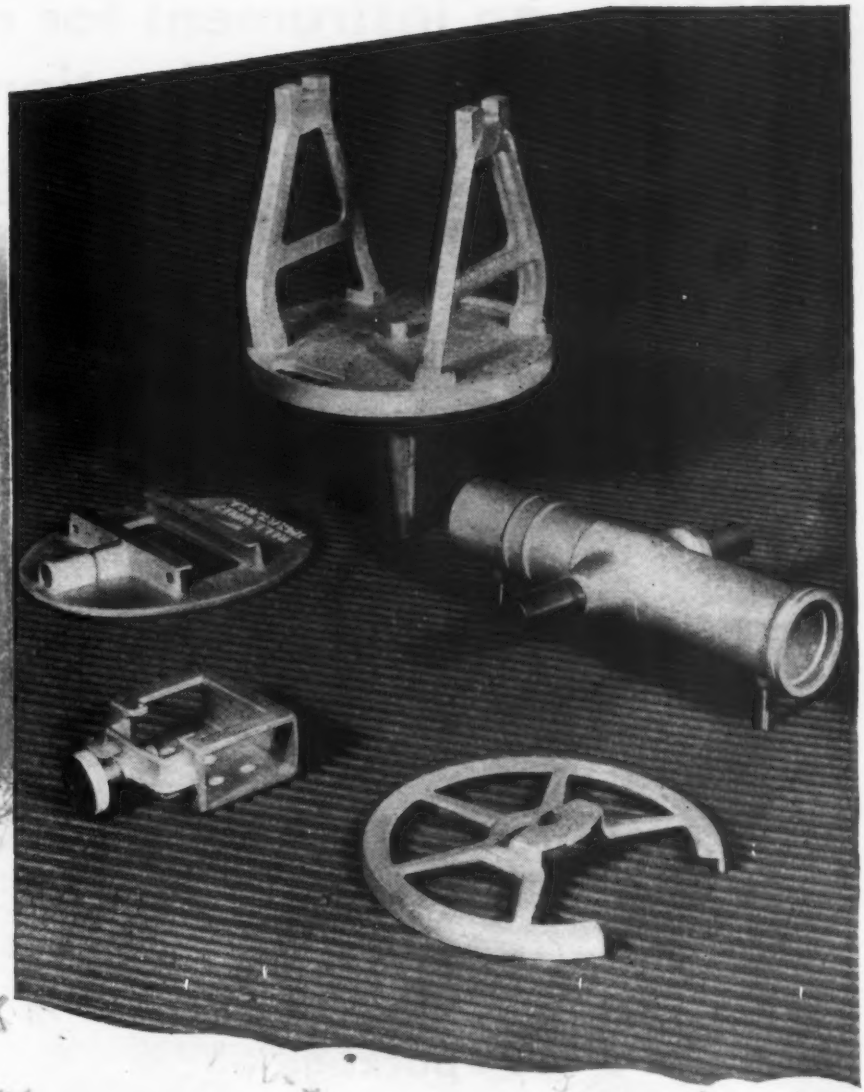
Torrington's two-row tapered roller bearings made of S.A.E.-3310 steel (with higher nickel content), carry the thrust loads imposed on the back-up rolls of this 80" four-high continuous hot strip mill. They provide a much-needed anti-friction application which helps achieve peak wartime tonnages. Features include simplicity of design, controlled lubrication and clearances which permit ready removal from roll necks. Each bearing has a thrust load capacity of 220,900 pounds at 100 r.p.m.—employing 23 rollers, 2¼" long by 2" in diameter, in each of the two rows.

Supplying steel, oil, paper, machine tool and other industries with custom-made bearings for heavy-duty operations is an important function of Torrington's Bantam Bearings Division. Consult Torrington's engineering staff when you have an anti-friction problem, standard or unusual.

THE TORRINGTON COMPANY · BANTAM BEARINGS DIVISION
SOUTH BEND 21, INDIANA

TORRINGTON BEARINGS

STRAIGHT ROLLER · TAPERED ROLLER · NEEDLE · BALL



These Alcoa Aluminum Alloy die castings go into the Gurley Model 132-B Precise Transit.

Army Engineers at work with Gurley Precise Transit on the Alcan Highway. Photograph by U. S. Army Signal Corps.

They get there with

Alcoa Aluminum Alloy Die Castings

Surveyors "stay on the beam" when they're working with this Gurley Precise Transit. Accurate when it leaves the factory, it stays that way, for the dimensions of these aluminum alloy parts are permanent. There's no creeping or growth when die castings are made of strong aluminum alloys.

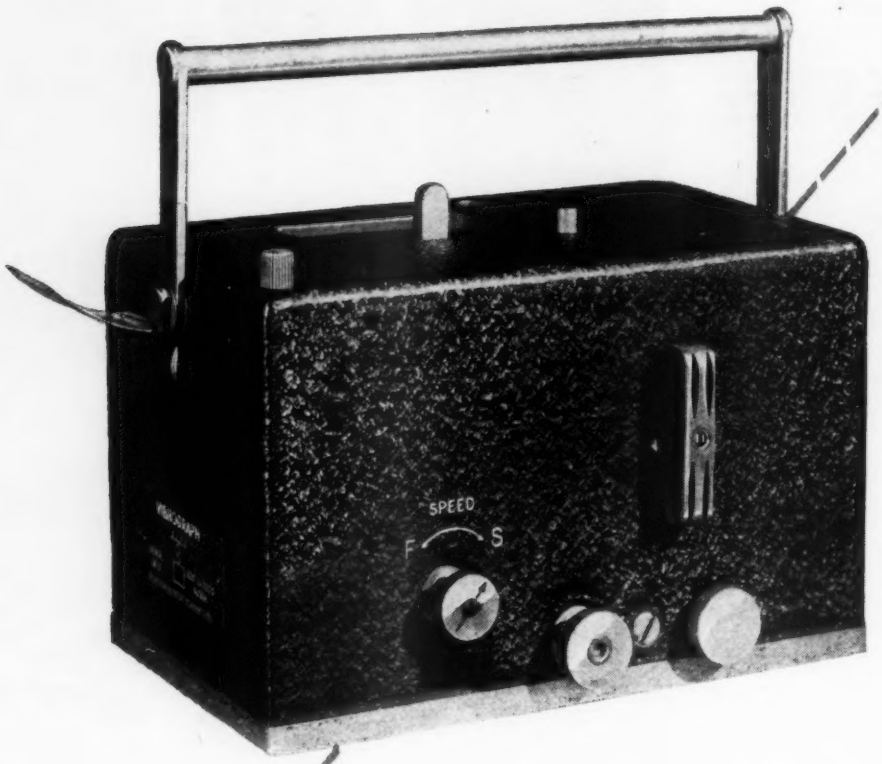
Manufacturers find that Alcoa Aluminum Alloy die castings speed up their work. Dimensions can be close to finished sizes; very little machining is required before a part is ready for assembly.

Alcoa gives you your choice of die castings in aluminum or magnesium. Both metals have permanence of dimensions and provide high strength-weight ratios. ALUMINUM COMPANY OF AMERICA, 2193 Gulf Building, Pittsburgh 19, Pennsylvania.

ALCOA FIRST IN **ALUMINUM**

ALCOA ALUMINUM

now—an instrument for measuring and recording vibration



in a 4″ x 5″ x 7″ package

Westinghouse announces the Vibrograph—a handy, portable instrument that instantly produces a permanent graphic record of the frequencies and amplitudes of all mechanical vibrations. Its operation is entirely mechanical . . . with no external connections to make, no data to record, no films to develop.

The new Westinghouse Vibrograph measures vibrations in the frequency range of 600 to 15,000 cycles per minute, with amplitudes as small as .0001″ or as great as 1/16″. These vibrations are permanently recorded by the instrument on a transparent celluloid strip. The strips can then be immediately examined under a low-power microscope—which is included with each Vibrograph.

A new illustrated bulletin, B-3046, gives complete information about the new Westinghouse Vibrograph. Write for your copy today. Westinghouse Electric & Manufacturing Company, Box 868, Pittsburgh 30, Pa.

J-08094

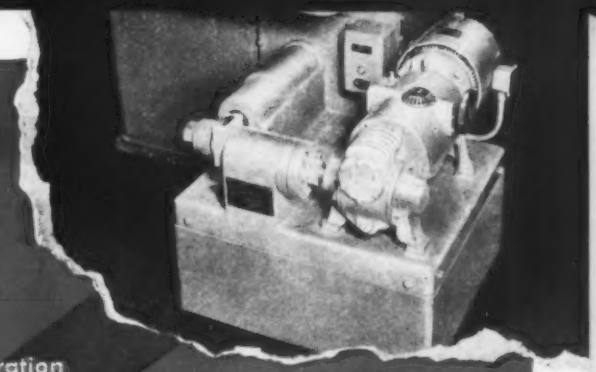
ONLY THE WESTINGHOUSE VIBROGRAPH GIVES YOU ALL THESE ADVANTAGES . . .

- Wide Operating Range
- Makes Permanent Record
- No External Connections
- Fast Automatic Operation
- No Wearing Parts
- Seismic or Prod Function
- May be Used in Any Position
- Compact Construction
- Completely Portable
- No Films to Develop

Westinghouse

Vibration Analysis

Instruments



Stepless **VARIABLE SPEED** operation offers tremendous advantages on many applications. You, yourself, probably have several applications on which variable speed operation would improve the quality of the product and increase the quantity of production as well.

For example, look at this oxygen generator which produces from ordinary air, absolutely dry oxygen that is at least 99.5% pure. This Speedranger provides stepless variable speeds so that pure oxygen and only pure oxygen is pumped off. Provides a high uniform quality product at peak production rate.

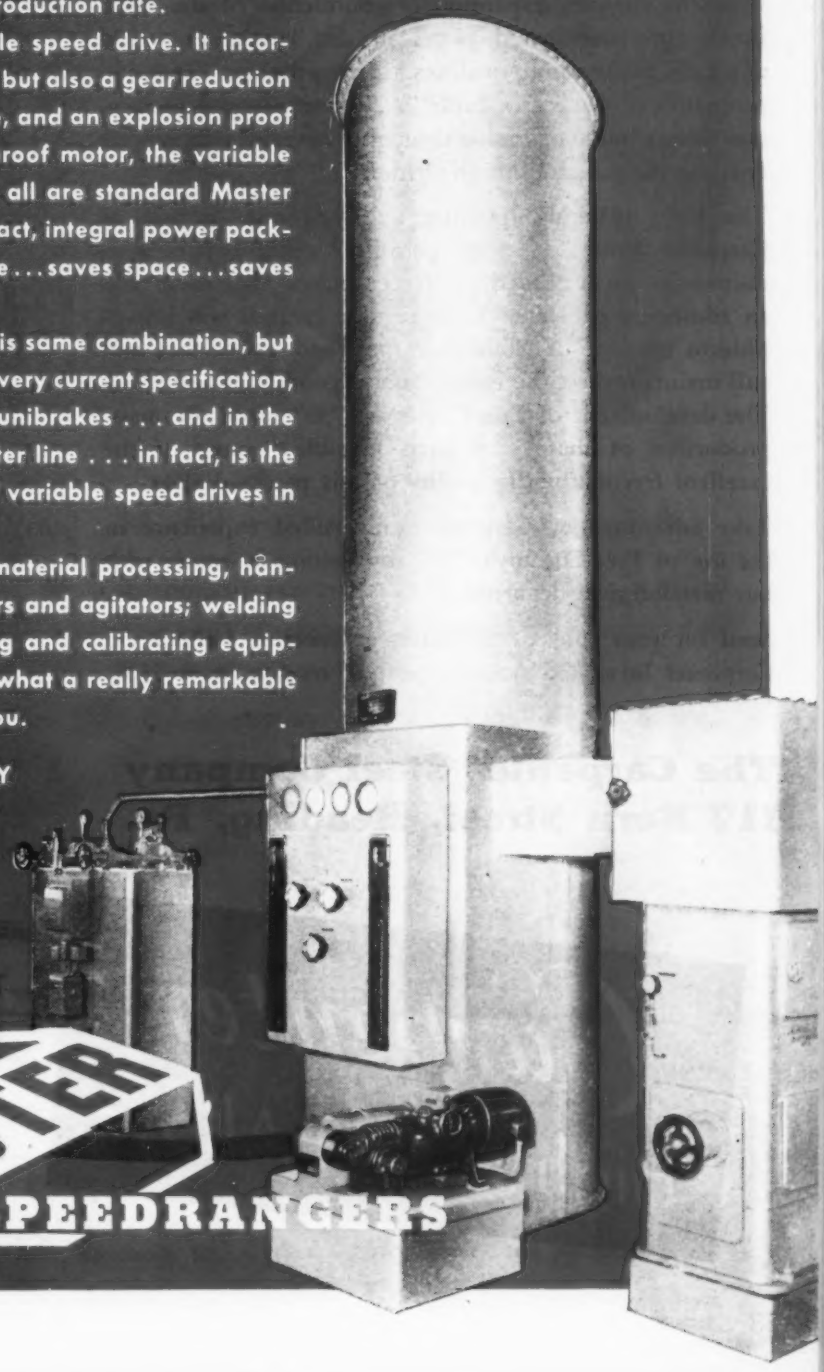
But look more closely at this variable speed drive. It incorporates not only the variable speed unit, but also a gear reduction to give speeds in exactly the right range, and an explosion proof motor. All of these . . . the explosion proof motor, the variable speed unit, and the gear reduction . . . all are standard Master units that easily combine into one compact, integral power package. Saves ordering and mounting time . . . saves space . . . saves money.

Probably you will not need exactly this same combination, but Master Speedrangers are available for every current specification, every type enclosure, with gearheads, unibrakes . . . and in the whole wide range of types in the Master line . . . in fact, is the most flexible, the most versatile line of variable speed drives in the world.

The next time you need a drive for material processing, handling, and conveying equipment; mixers and agitators; welding positioners; machine tool drives; testing and calibrating equipment . . . to name only a few . . . see what a really remarkable job Master Speedrangers can do for you.

THE MASTER ELECTRIC COMPANY

DAYTON 1, OHIO



MASTER SPEEDRANGERS

How Free-Cut Invar "36" solved Aircraft Radio Problem

Mass Production of Precision Condenser Parts Made Possible

Do you need a low expansion alloy that machines easily for your new or redesigned products?

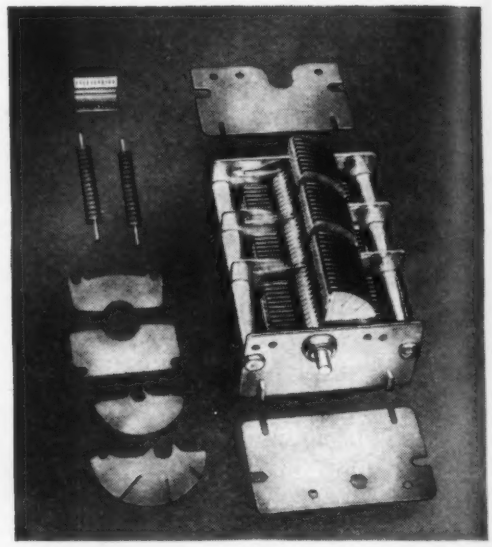
Here's a striking example of how Carpenter Free-Cut Invar "36" solved the problem of mass-producing machined condenser parts used in a military aircraft radio.

Even the slightest expansion or contraction of the metal in the precision-spaced plates in this condenser would affect the radio tuning qualities. Hence, the low expansion properties of Carpenter Invar "36" were essential to accurate aircraft radio operation through a range of temperature from on the ground to high altitude.

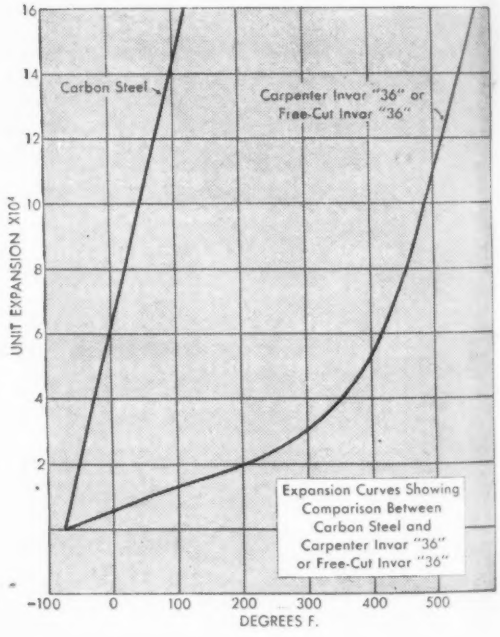
The good blanking qualities and uniform gauge of Carpenter Invar "36" strip permitted rapid volume production of these needed condenser plates. But there was an additional problem. With regular invar it was impossible to machine the condenser shaft and spacer bars and still maintain the close tolerance and good finish required. The development of Free-Cut Invar "36" made the mass-production of these vital parts possible because of the excellent free-machining quality of this patented alloy.

Take advantage of Carpenter's diversified experience in the use of Free-Cut Invar "36" by getting in touch with our metallurgical department.

Send for your copy of our latest engineering bulletin on Carpenter Invar "36" and Carpenter Free-Cut Invar "36".



Precision Radio Condenser with Invar plates, shafts and spacer bars.



The Carpenter Steel Company
117 Bern Street, Reading, Pa.

Carpenter
High Nickel Alloys

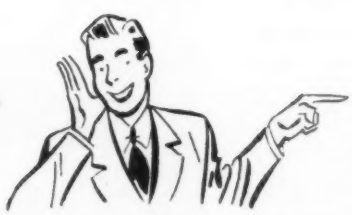
- Temperature Compensator "30"
- Carpenter Invar "36"
- Carpenter Free-Cut Invar "36"
- Glass Sealing "42"
- High Permeability "49"

A hand grenade with a beautiful finish? Yes, American made hand grenades ARE beautifully finished with lacquer enamels to resist wear and corrosion.

M & W's paints, lacquers and enamels are on hundreds of war materials, from gas masks and bombs to airplanes. Each type of equipment has a different finish requirement and M & W has produced all of them to meet Government specifications.

Although a bomb or a hand grenade can't be called beautiful, a post-war refrigerator or automobile CAN! If you're thinking now about the finish of your post-war product, think M & W finishes. There are hundreds of them, designed to meet any requirement and to give your post-war product eye appeal.

HERE'S A POST-WAR TIP—



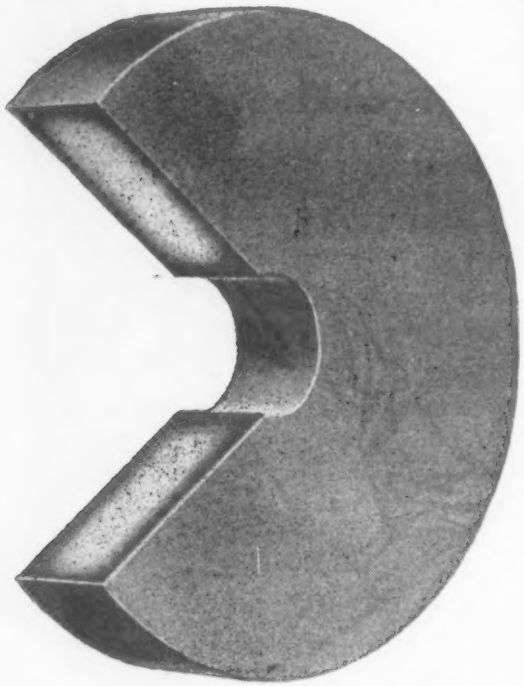
"EYE APPEAL GIVES YOUR PRODUCT BUY APPEAL!"

MAAS & WALDSTEIN COMPANY, NEWARK, N. J.

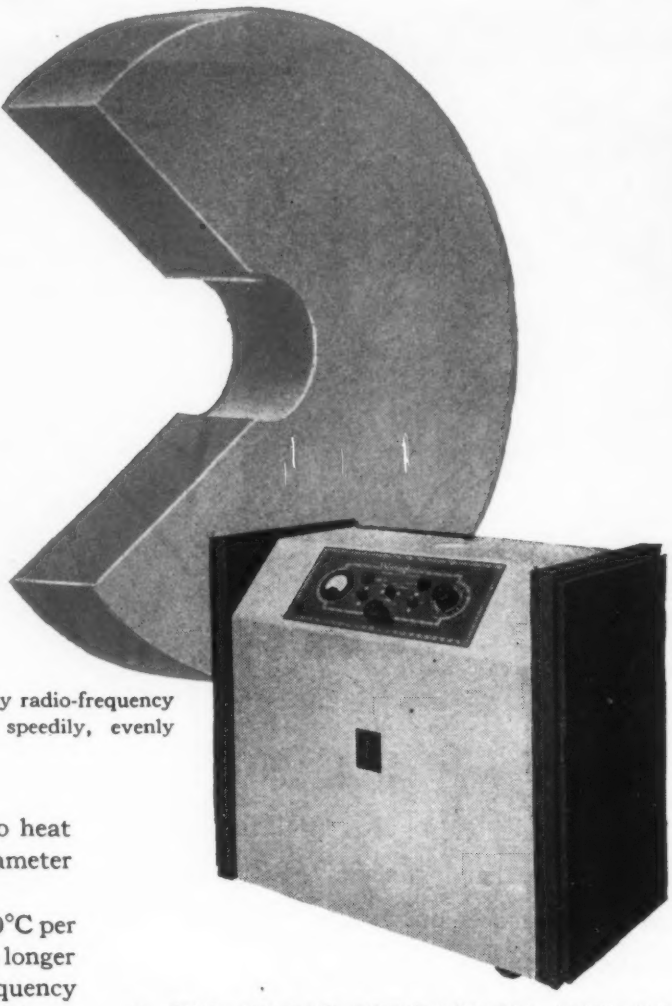
PRODUCERS OF LACQUERS, ENAMELS, SYNTHETICS AND SPECIALTY FINISHES FOR ALL PURPOSES

BRANCH OFFICES & WAREHOUSES: 1658 CARROLL AVE., CHICAGO, ILL. • 1228 W. PICO BLVD., LOS ANGELES, CALIF.

two-day curing job.. cut to 7½ minutes



Cross section of grinding wheel . . . formerly oven baked . . . heat soaks in slowly from surface.



Same section . . . now cured by radio-frequency heating . . . heat builds up speedily, evenly throughout.

The old, slow oven cure took 48 hours—just to heat the resin bond of a grinding wheel 8½" in diameter by 1¼" thick.

Now 7½ minutes are plenty . . . heat mounts at 20°C per minute . . . and splitting due to uneven heating is no longer a major hazard. Now it's done by radio frequency which heats dielectrics uniformly from center to skin.

This speedy heating is often applicable to processes in wood, chemicals, plastics, rubber, textiles and dozens of other products—with no waiting for heat to "soak in" and no rejects due to overheated surfaces.

This accurate, uniform heating is simplified into a "push button" job for unskilled help, with all equipment and controls in one safe, spacesaving cabinet. The cabinet is shielded to minimize interference with radio communications.

Single standard units are available in output capacities ranging up to 200 kw. The range of frequencies is wide enough for almost every dielectric and induction heating need. For more information, write for Descriptive Data 85-800. Or, for suggestions on a specific application, ask a Westinghouse engineer to call. Westinghouse Electric & Manufacturing Co., P.O. Box 868, Pittsburgh 30, Pa. J-08097

2 KW RADIO-FREQUENCY GENERATOR

This unit has a nominal output of 2 kw. Controls and meters are all conveniently located on front panel. Circuit breaker and relays are readily accessible through the lower door on left side of cubicle.

Westinghouse

PLANTS IN 25 CITIES . . . OFFICES EVERYWHERE

Electronics at Work

LOOKING FOR A VERSATILE MATERIAL?

● The end bells illustrated above were manufactured by the Sampsel Time Control Company. Used as casings for covering the end connections of high speed electric machines, these small but vital items are no simple job to produce. The machine tolerances are quite close and the parts must have a high degree of stability. In fact the boring of a seat for a ball bearing is held to .0003" tolerance while one shoulder diameter is turned to .0008" tolerance.

As a result of an ingenious mold design, these end bells are molded in a single operation. Notice how the inserts are molded-in making for ease of assembly and fabrication.

The tremendous progress which America's custom molders have made during the past three years in developing new molding methods and processes is exemplified by the efficient production of just such items as these end bells.

The material selected for these end bells was a general-purpose Durez phenolic molding compound. Besides possessing excellent moldability, this Durez compound possesses such versatile properties as oil and grease resistance, dielectric strength, self-insulation, excellent wearability and heat resistance.

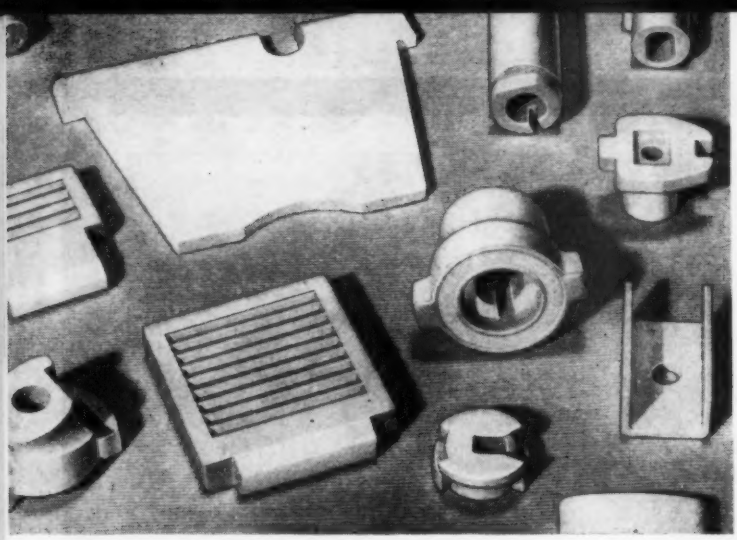
The unusual versatility of Durez phenolics has made their usage practically universal throughout industry. Add to this the quarter century's experience which Durez technicians have acquired through active participation in the successful development of many plastic products and you can readily appreciate the benefits of working with our organization. The services of the Durez staff are available at all times to you and your custom molder. Durez Plastics & Chemicals, Inc., 304 Walck Road, North Tonawanda, N. Y.

DUREZ

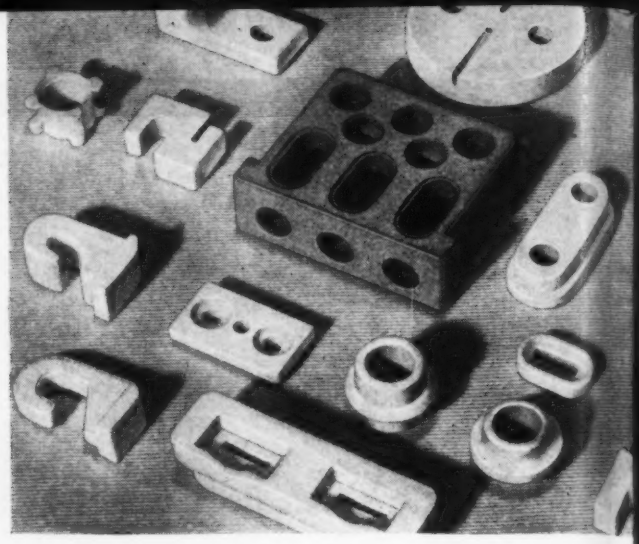
PHENOLIC RESINS

- MOLDING COMPOUNDS
- INDUSTRIAL RESINS
- OIL SOLUBLE RESINS

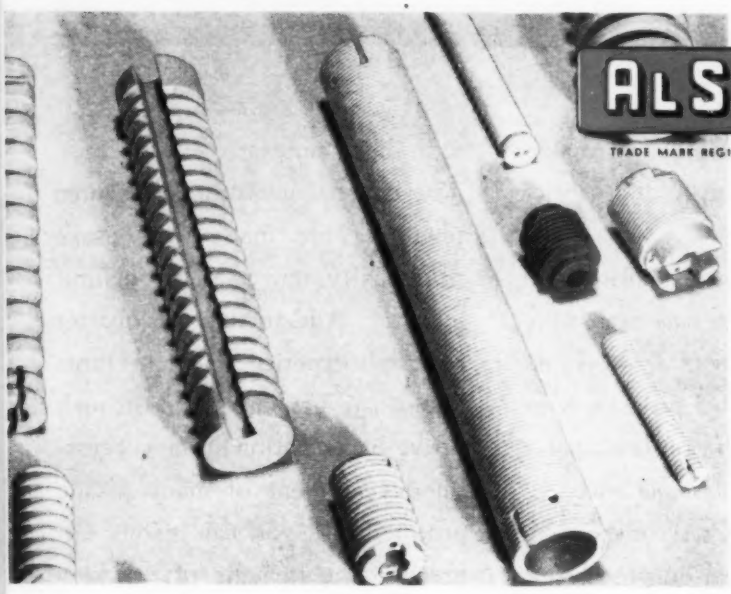
PLASTICS THAT FIT THE JOB



PARTS FOR ELECTRICAL CONTROLS Throughout the field of small electrical control equipment ALSIMAG parts are found at key points in assemblies. Here again dimensional accuracy, high dielectric strength, low porosity and resistance to heat of ALSIMAG Ceramic Insulators facilitate compact design and assure dependable operation.



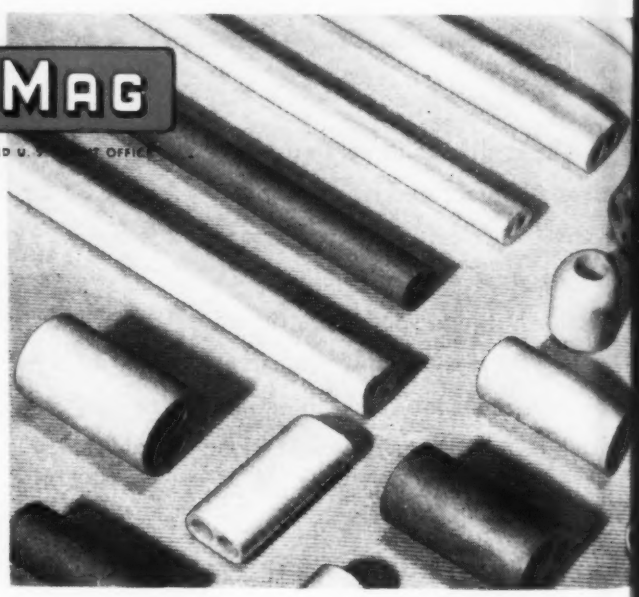
ELECTRICAL APPLIANCE PARTS Produced in ALSIMAG heat resistant compounds by die-pressing, these parts find wide acclaim among appliance manufacturers because of their dependability and uniformity. Ease of assembly and trouble-free service characterize ALSIMAG appliance parts.



ALSIMAG

TRADE MARK REGISTERED U. S. PAT. OFFICE

THREADED CORES Countless combinations for dimension and pitch are produced regularly for the electrical heater industry. Lengths up to 24" are common. Resistance to heat at elevated temperatures and dimensional uniformity make ALSIMAG Threaded Cores ideally suited to straight, sealed units.



THERMOCOUPLE INSULATORS Preferred by instrument servicemen, ALSIMAG Thermocouple Insulators are uniform, clean-bored and strong. These simple tubes play a vital part in the control of high temperature equipment. A complete line of ball-and-socket beads is available.

FOR COMPACT DESIGN, EASE OF ASSEMBLY AND DEPENDABLE OPERATION

The ideal electrical properties of ALSIMAG Insulators, together with high mechanical strength and rigidity, assure compact design and dependable operation. Dimensional accuracy facilitates assembly. Made of permanent, heat-resisting materials which cannot char, ALSIMAG Insulators are economical because of high speed production methods. Let us prove that ALSIMAG Insulators are best suited to your requirements.

CHARACTERISTICS OF ALSIMAG INSULATORS

- High Mechanical Strength
- Permanent Rigidity
- Low-Loss Factor
- High Dielectric Strength
- Will Not Absorb Moisture
- Chemically Inert
- Heat Resistant
- Precision Made of Purest Raw Materials

ARMY ★★ E ★★ NAVY

ALCO has been awarded for the time the Army-Navy "E" Award continued excellence in quantity quality of essential war produc

AMERICAN LAVA CORPORATION • *Chattanooga 5, Tennessee*

43RD YEAR OF CERAMIC LEADERSHIP

When you modernize...

USE A GEARMOTOR

W.P.B. indicates that we'll all be pushing war production for many months. And then the heat goes on reconversion.

Much of your equipment, running at peak load since 1941, probably needs to be replaced or modernized. Whichever you need . . . replacement or modernization . . . use a gearmotor when the drive requires speed reduction. Here's why.

A gearmotor is the most efficient means of speed reduction available today. It's more compact . . . lasts longer with less maintenance . . . is easier to install . . . lower in over-all cost . . . and safer for your employees. These advantages are not idle claims . . . for they've been proved in actual industrial installations.

Westinghouse offers a complete line of gearmotors for any speed reduction application from 1 to 75 hp. Each unit is specifically designed to conform to industry-wide A.G.M.A. standards. Each new unit contains many improved exclusive design features. Call your nearest Westinghouse office for details. Westinghouse Electric & Manufacturing Company, P. O. Box 868, Pittsburgh 30, Pennsylvania.

J-07227

WESTINGHOUSE

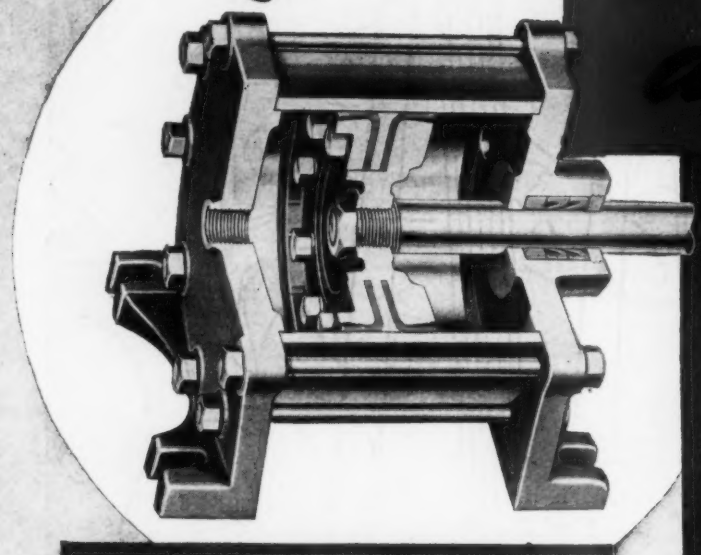
Westinghouse Gearmotors

PLANTS IN 25 CITIES . . . OFFICES EVERYWHERE

Four out of five drives need speed reduction

Replace Inefficient Hand and Mechanical Operations.

Get FAST-ACTING, POSITIVE, CONTROLLED POWER at Low Cost...



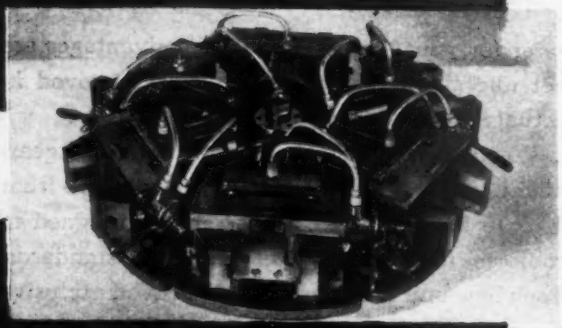
with **Logan** NON-ROTATING

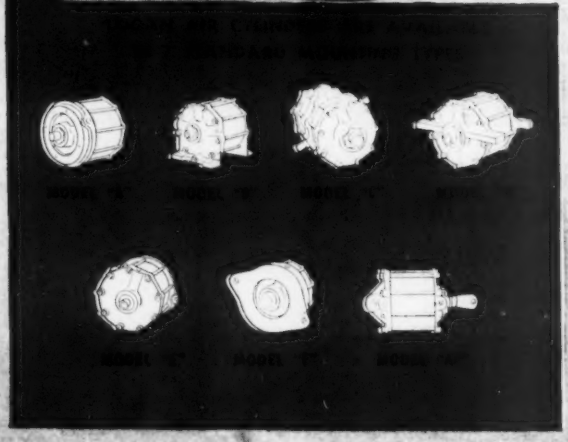
AIR CYLINDERS

FOR • PUSHING • PULLING • LIFTING HOLDING and OTHER APPLICATIONS

These Logan Features Assure Peak Performance and Long Life

- Quicker response obtained through larger ports.
- Higher pressures permitted by more sturdy construction; heavy duty nickel-chrome iron covers. Bronze bushing supports and aligns piston rod.
- Cylinders can be furnished with cushioning at one or both ends to eliminate shock at end of stroke.
- Maximum power without leakage assured by molded composition packing cups, self-adjusted by air.
- Permanent seal around rod provided by sea ring packing, self-adjusted by air.





To get fast-acting, convenient power for pushing, pulling, lifting and holding operations, replace inefficient hand actuation with *standard* LOGAN Air Cylinders. Many profitable advantages can be obtained that will increase production in industrial applications of all kinds.

The constant power with follow-up assures positive, uniform actuation. Control valves may be located at any convenient point, adjacent or remote. Important savings in operator time and fatigue will result. In addition the use of LOGAN Air Cylinders often permits simplifying the design of a mechanical structure and reducing amount of floor space required.

LOGAN Air Cylinders are available in 7 types of mounting to fit almost every requirement; interchangeable end covers permit a wide range of combination mountings. Manufactured in sizes from 1½" to 24" bore with any length of stroke up to 18 feet. Recommended for operation at pressures up to 150 p.s.i.

ENGINEERING ADVICE . . .

Write for recommendations on the proper cylinders for your applications and most effective methods of installation. No obligation.

USE COMPLETE LOGAN AIR EQUIPMENT . . .

For highest efficiency, use Logan equipment throughout in your complete air installations. Logan cylinders, control valves and air accessories are designed to work together as a balanced air system.

ARMY E NAVY

FREE CATALOGS FOR YOU

Logan

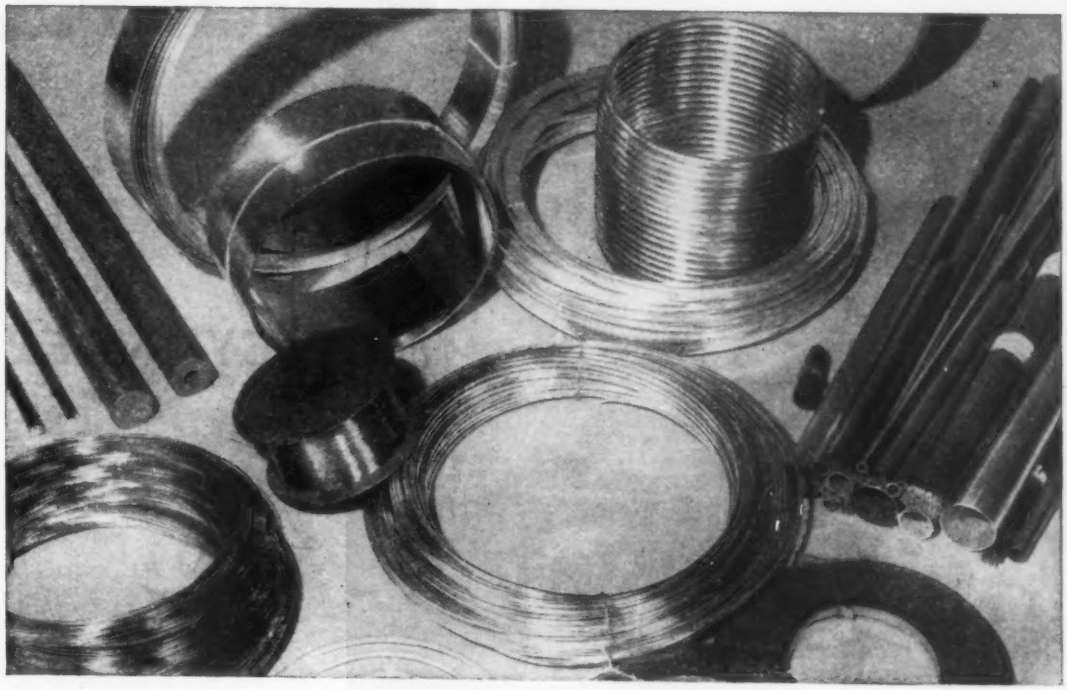
Air and Hydraulic Equipment

LOGANSPORT MACHINE CO., INC.

911 PAYSON RD
LOGANSPORT
INDIANA

CHUCKS • CYLINDERS • VALVES • PRESSES • SURE FLOW COOLANT PUMPS

Write for complete information on LOGAN Air Cylinders, control valves and air accessories...also other items in the LOGAN line which can help you.



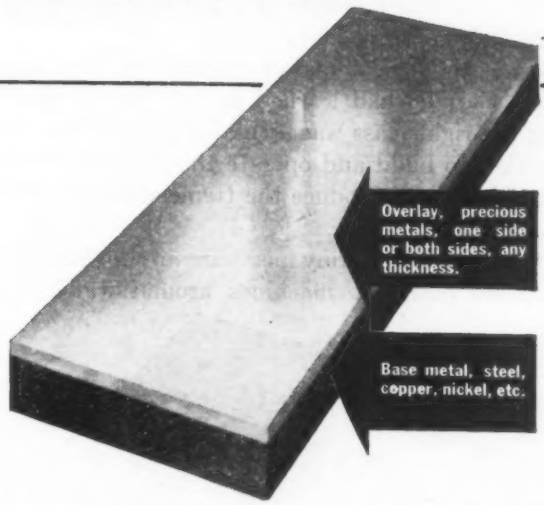
FROM PEANUT TUBES TO

Giant Turbines

Versatile GENERAL PLATE LAMINATED METALS Can Improve Performance, Cut Costs

Whether you're working on products for immediate use or planning and designing your contemplated post-war products, General Plate Laminated Metals . . . sheet, wire or tube . . . can definitely fit into your product picture.

These versatile permanently bonded laminations of precious metals to base metals or base to base metals increase performance and cut costs in such products as electrical equipment, aircraft, radio, electronic devices, ships, tanks and chemical apparatus. A few of their advantages are that they provide better electrical performance, maximum resistance to corrosion, long life and ease of fabrication . . . yet they cost but a fraction of the cost of solid precious metals.



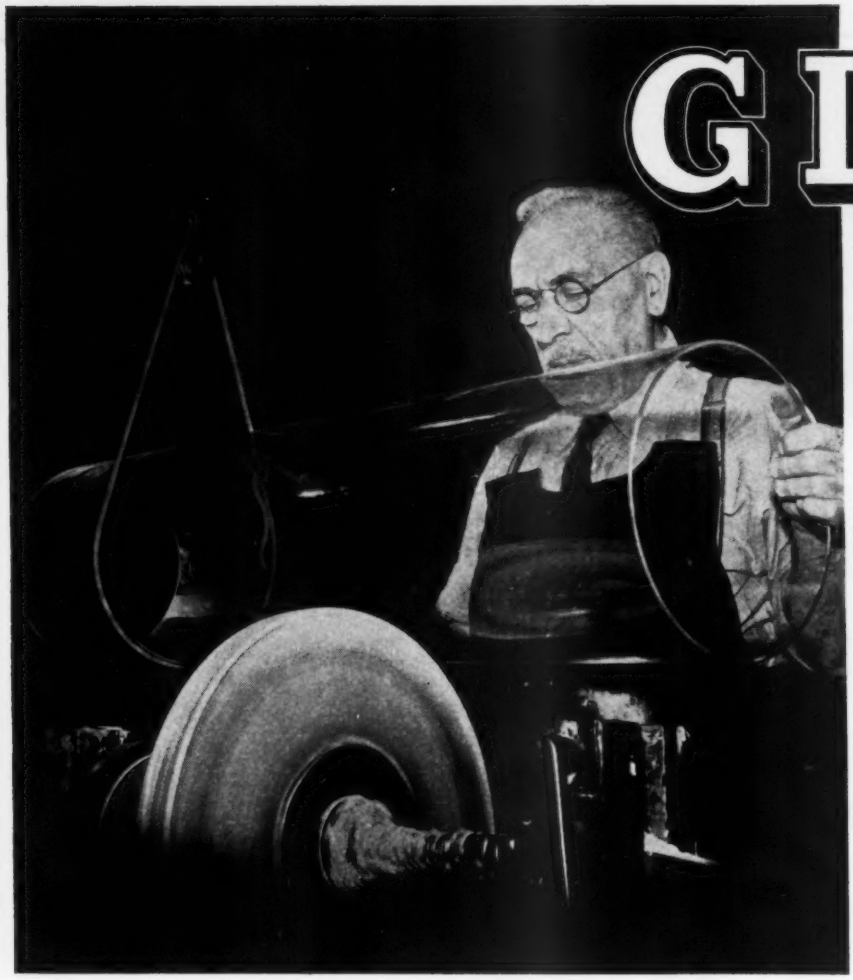
General Plate Laminated Metals are available inlaid or wholly covered in raw stock or fabricated parts. Our engineers will gladly consult with you on your problems. Write for their services.

General Plate Division

of Metals & Controls Corporation

50 Church St., New York, N. Y.; 205 W. Wacker Drive, Chicago, Ill.; 2635 Page Drive, Altadena, California; Grant Bldg., Rm. 603, Pittsburgh, Pa.

ATTLEBORO, MASSACHUSETTS



GLASS

FROM BLUEPRINT CYLINDERS TO COFFEE CUPS

When the armed services needed messware—in mass production quantities and tough enough to stand up under the none-too-gentle handling of a KP or galley detail—they didn't have far to look.

Glass was the logical answer—because of the ruggedness that Corning had learned to put into it. And at Corning the right glass was available . . . and the engineering skill to build and operate the high-speed automatic machinery to produce the tremendous quantities of ware needed.

In sharp contrast to army messware are the huge glass cylinders for blueprint machines around which have rolled the tons upon tons of blueprints for the fighting machines of our armed forces. This is a job for skilled craftsmen, not for automatic production . . . and a job for PYREX brand Glass No. 774, because the cylinders must resist the intense heat of arc lamps and transmit a maximum of light.

Army messware and blueprint cylinders are just two of the many products made possible by Corning's engineering skill, production facilities, and the thousands of Corning glass compositions. They may provide the solution to your problem.

Write Industrial Sales Department PE-4.

CORNING GLASS WORKS
CORNING, NEW YORK

CORNING means Research in Glass

INDUSTRIAL GLASS by CORNING

"PYREX" and "CORNING" ARE REGISTERED TRADE-MARKS AND INDICATE MANUFACTURE BY CORNING GLASS WORKS, CORNING, N.Y.

INDUSTRIAL SALES DEPT., PE-4—
Corning Glass Works, Corning, New York

Please send me a copy of your Bulletin 842—
"*Industrial Glass by Corning.*"

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LOW-LOSS—DESPITE HEAT AND HUMIDITY

BM-16981 is a new phenolic, mica-filled molding material with extraordinary low-loss characteristics under hot, humid conditions. BM-16981, indeed, retains its superior insulation qualities after long periods of immersion—greatly surpassing in this important respect all other mica-filled phenolics tested by the Bakelite Laboratories.

With its extreme resistance to water absorption, its excellent dielectric properties, and good molding qualities, BM-16981 brings you the opportunity to improve the performance of molded parts in applications subjected to heat and high humidity.

Specify BAKELITE molding material BM-16981 for completely new measures of service where atmospheric conditions are generally unfavorable for electrical insulation. Department 21 will be glad to send you detailed information upon request.

TRADE MARK

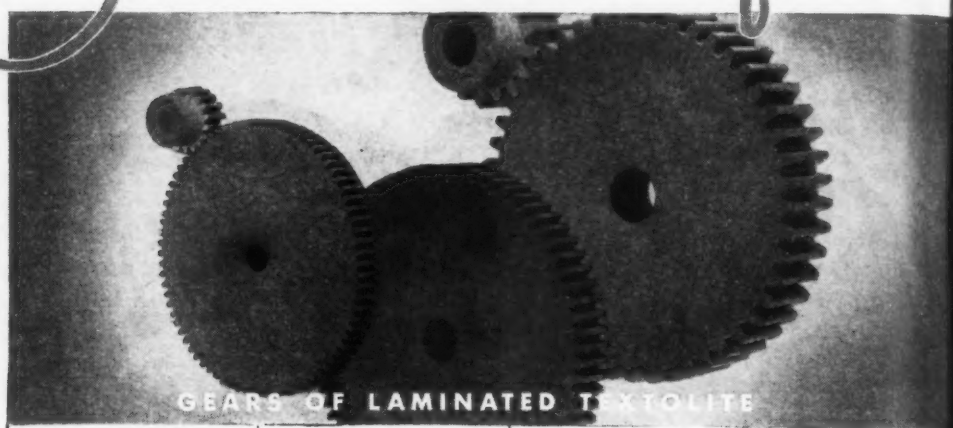
BAKELITE CORPORATION
Unit of
Union Carbide and Carbon Corporation

UCC

30 EAST 42ND STREET, NEW YORK 17, N.Y.

Molding Plastics

PLASTICS in the Industrial field



OTHER TYPICAL APPLICATIONS

LAMINATED	Roll-neck Bearings	Rayon Spinning Bucket	Caster Wheel	Sheave
THERMOPLASTIC	Signal Light Dome	Safety Guard	Gear	Air Trap For Milking
PHENOLIC	Spigot For Milking Machine	Control Housing	Meter Housing	Handwheel
G-E MYCALEX	End Plate	Coil Insulator	Relay Insulator	Rectifier Vibrator

To reach a sound conclusion to your problem in plastics consult the skilled technicians—engineers and designers—of the General Electric Company. For advice on the successful application of plastics materials using all available processes of manufacture, write Section PD-28, General Electric Company, One Plastics Avenue, Pittsfield, Mass., or call the General Electric Plastics Divisions' office nearest you.

Hear the General Electric radio programs: "The G-E All-girl Orchestra" Sunday 10 P.M. EWT, NBC. "The World Today" news every weekday 6:45 P.M. EWT, CBS. "G-E House Party" every weekday 4:00 P.M. EWT, CBS.

A G-E PLASTICS TECHNICIAN ***KNOWS*** PLASTICS

Buy War Bonds

GENERAL ELECTRIC PD-28

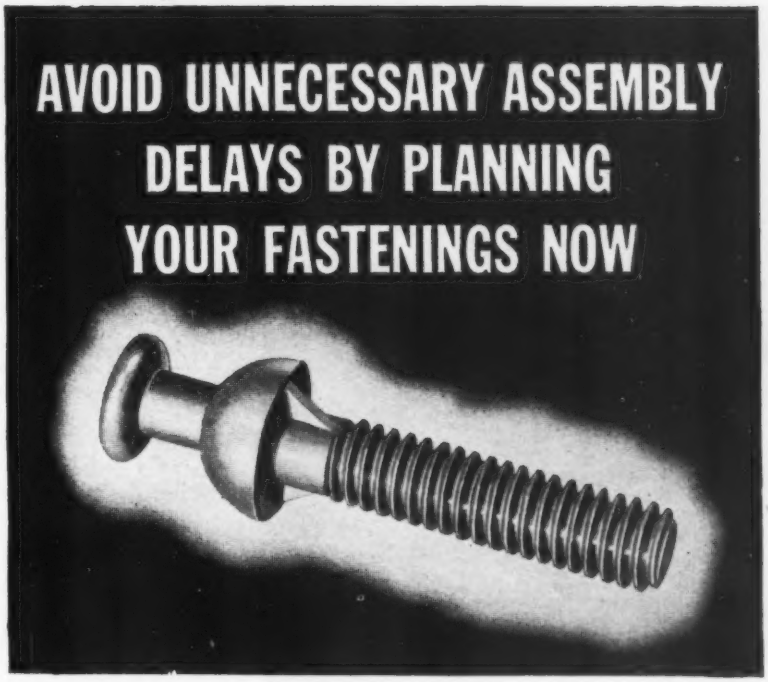
3 Standard Fastenings for Production Efficiency

1 **Phillips Recessed Head Screws**—The modern, effective, time-saving fastening device proven in tens of thousands of assembly lines. Other standard head styles are also available.

2 **Self-Tapping Machine Screws**—Eliminate separate tapping operations for fastenings to castings, heavy gauge sheet metal, and plastics. Also available with Phillips Recessed Head.

3 **Washer-Screw Assemblies**—When use of lock washers is indicated, the time-saving of pre-assemblies is obvious. Also available in standard slotted head styles.

AVOID UNNECESSARY ASSEMBLY DELAYS BY PLANNING YOUR FASTENINGS NOW



"Cold-forging"— proof #30 ...more each month

Forethought, when your product is still in the design stage, can mean timely delivery of fastenings for that "long planned" fast assembly job. Your early and precise choice of fastenings—standard or special—may be vital to the fast and exacting assembly job required for an advantageous start on postwar production.

That's where Scovill comes in . . . our broad experience in fastenings and ingenuity in special design qualify us as specialists in the fastenings field. Let us help you determine the best modern fastenings to use—a featured standard fastening or a part especially designed to suit your needs.

The part shown above is one of Scovill's many special purpose cold-forged items. Our special processing of this part meant substantial savings in money—materials—motions. Call our Fastenings Expert for assistance so that you likewise may profit. Call him **now.**

SCOVILL MANUFACTURING COMPANY
WATERVILLE SCREW PRODUCTS DIVISION

WATERVILLE 48, CONN. TEL. WATERBURY 3-3151

NEW YORK, Chrysler Building . DETROIT, 714 Fisher Building . CHICAGO, 1229 W. Washington Boulevard . PHILADELPHIA, 18 W. Chelten Avenue Building
PITTSBURGH, 2882 W. Liberty Ave. . SYRACUSE, Syracuse-Kemper Insurance Bldg. . LOS ANGELES, 2627 S. Soto St. . SAN FRANCISCO, 434 Brannan St.

Catalin
A PARTY TO THE SHOWDOWN
The War Department's Chemical Warfare Service has developed a specific requirement for which Catalin has proven ideally suited! Small Catalin jars, ordinarily identified as cigarette humidors or cosmetic containers offered the design and structural form necessary to a newly devised and highly effective bombing pattern.
For the present, fulfillment of this vitally important assignment is requiring every possible ounce of Catalin's vast and complete production. And . . . even though such a situation curtails civilian-use Catalin, remember that the end purpose of the task at hand will mean a brighter future—sooner!
So, as Catalin continues to lay these needed bomb elements on the line . . . continue to lay your Catalin plans on the line, too. For this purpose the facilities and counsel of our technical staff are at your service!
CATALIN CORPORATION
ONE PARK AVENUE, NEW YORK 16, N. Y.
CAST RESINS • LIQUID RESINS
MOLDING COMPOUNDS
Catalin

IT MAKES LESS FUSS

A prewar refrigeration compressor built by York Ice Machinery Corporation. Pistons and connecting rods are Alcoa Aluminum permanent mold castings. Suction valves, discharge valve plates and cages are also aluminum.

about doing more work

Alcoa Aluminum Alloys help to make this York compressor lightweight and compact.

The V/W design has the same crank effort characteristics as does an "in line" cylinder arrangement. The lightweight aluminum pistons and connecting rods reduce reciprocating and rotating weights and make balancing easier, with consequent reduction in vibration. Higher rotative speeds are possible, therefore.

The aluminum alloy connecting rods serve as bearing metal, eliminating the need for bearing inserts at the crank and wrist pins. The high heat conductivity of the pistons helps to reduce compression chamber temperatures. And of great importance here, aluminum works well in contact with the refrigerant, Freon-12.

ALUMINUM COMPANY OF AMERICA, 2193 Gulf Building, Pittsburgh 19, Pennsylvania.

ALCOA FIRST IN ALUMINUM

The best trained troops require tempering under fire to become seasoned fighters. Springs, too, need proper tempering to fit them for the rigorous demands of tough fighting mechanisms. Because heat-treatment is so vital to spring performance, its selection and control come within the realm of our laboratory technicians, with automatic regulation that insures parade-ground precision—precise action—long service. No guesswork—Barnes-made Springs are under strict discipline in *every* stage of manufacture. They obey *your* orders.

CONSERVE METAL—DESIGN WISELY

1918–THEN AND NOW

Barnes-made Springs

ENGINEERED PEP AND POWER

WALLACE BARNES COMPANY DIVISION OF ASSOCIATED SPRING CORPORATION BRISTOL, CONNECTICUT, U. S. A.

LUMARITH* PLASTICS

present the case for beauty

THEY ARE INSPIRING new ideas in cosmetics container design . . . They are showing the way to more economical production . . . They are demonstrating how the inexpensive, expendable cosmetics container can be beautiful, smart and sales-appealing.

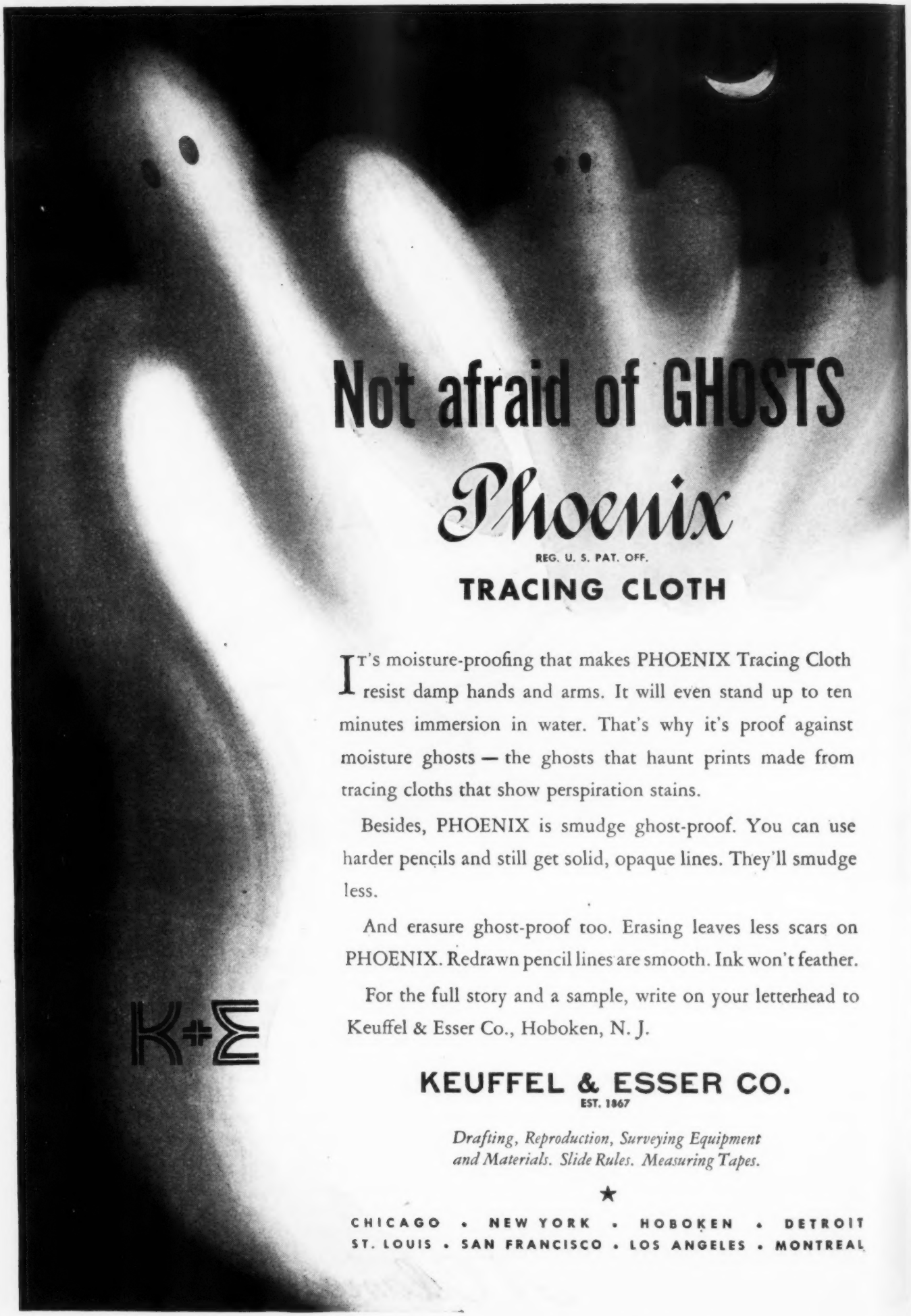
Lumarith is an old name in the cosmetics industry. Recently these versatile materials have served as alternates for war-scarce metals in many new applications. These newer roles are increasing as packaging stylists develop designs that take full advantage of Lumarith's unique characteristics of extreme lightness, superb color range, transparency and easy moldability.

The Lumarith molded container carries "lightly" in the handbag. Its chipproof surface actually improves with handling. The jade-like "feel" is inviting in all seasons.

Lumarith plastics are adaptable to high-speed, multiple-cavity injection molding. Molded surfaces require very little finishing and polishing. Intricate designs, raised or impressed lettering and close fitting threads are readily molded. The toughness of Lumarith provides strength without bulk and makes thin cross sections practical. You are invited to consult the technical staff of the pioneer plastics producers for specific information relating to your manufacturing problems. Celanese Plastics Corporation, *a division of Celanese Corporation of America*, 180 Madison Avenue, New York 16, N.Y.

A Celanese Plastic*

*Reg. U.S. Pat. Off.



Not afraid of GHOSTS

Phoenix

REG. U. S. PAT. OFF.

TRACING CLOTH

IT'S moisture-proofing that makes PHOENIX Tracing Cloth resist damp hands and arms. It will even stand up to ten minutes immersion in water. That's why it's proof against moisture ghosts — the ghosts that haunt prints made from tracing cloths that show perspiration stains.

Besides, PHOENIX is smudge ghost-proof. You can use harder pencils and still get solid, opaque lines. They'll smudge less.

And erasure ghost-proof too. Erasing leaves less scars on PHOENIX. Redrawn pencil lines are smooth. Ink won't feather.

For the full story and a sample, write on your letterhead to Keuffel & Esser Co., Hoboken, N. J.

K+E

KEUFFEL & ESSER CO.
EST. 1867

Drafting, Reproduction, Surveying Equipment and Materials. Slide Rules. Measuring Tapes.

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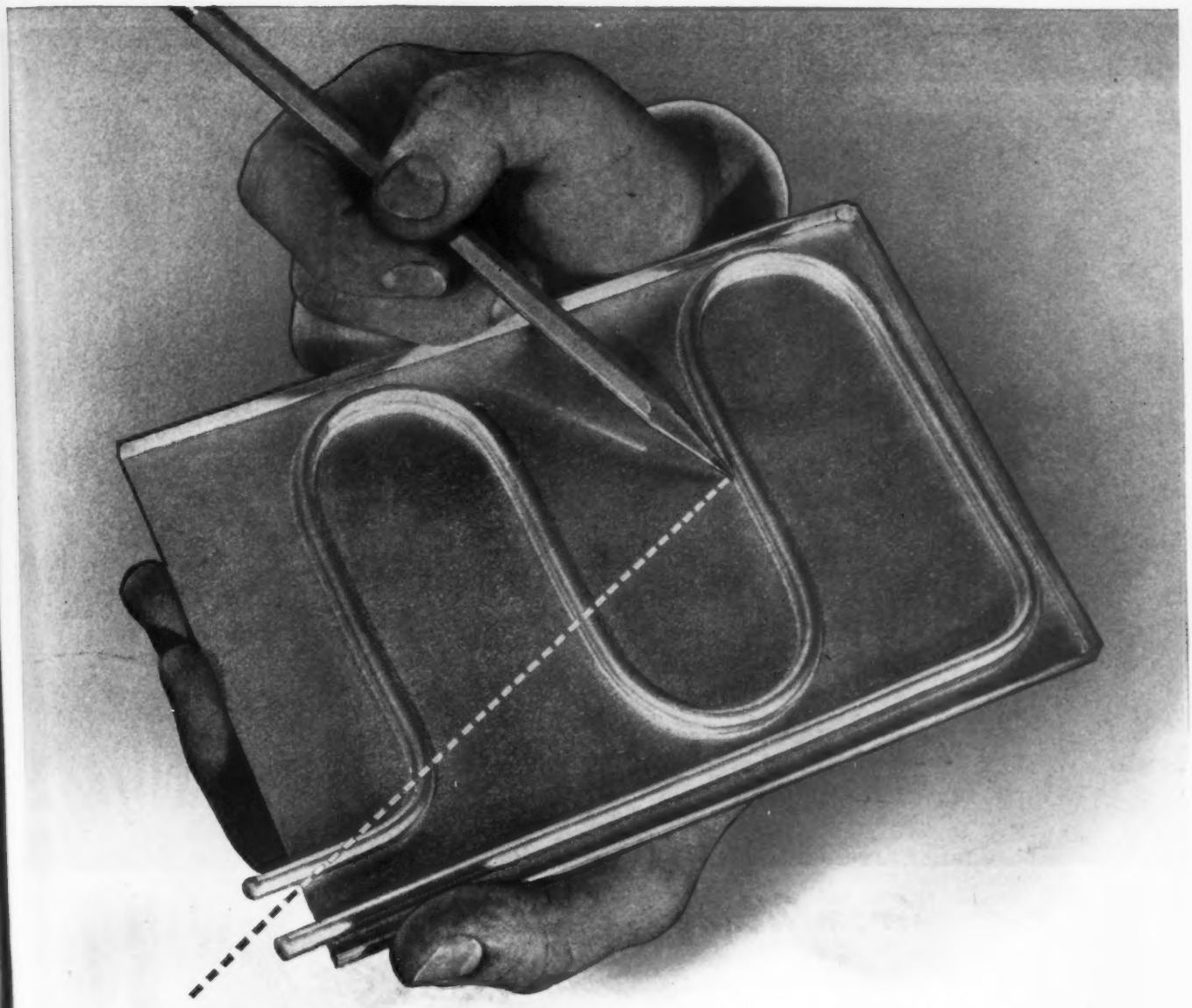


BRAZING removes an obstacle to rapid heat transfer

Brazing produces excellent joints, speeding up chilling and freezing by making it easy for heat to get out. Use this process in connection with aluminum—a superior heat conductor—and you have the answer to many of your heat transfer problems.

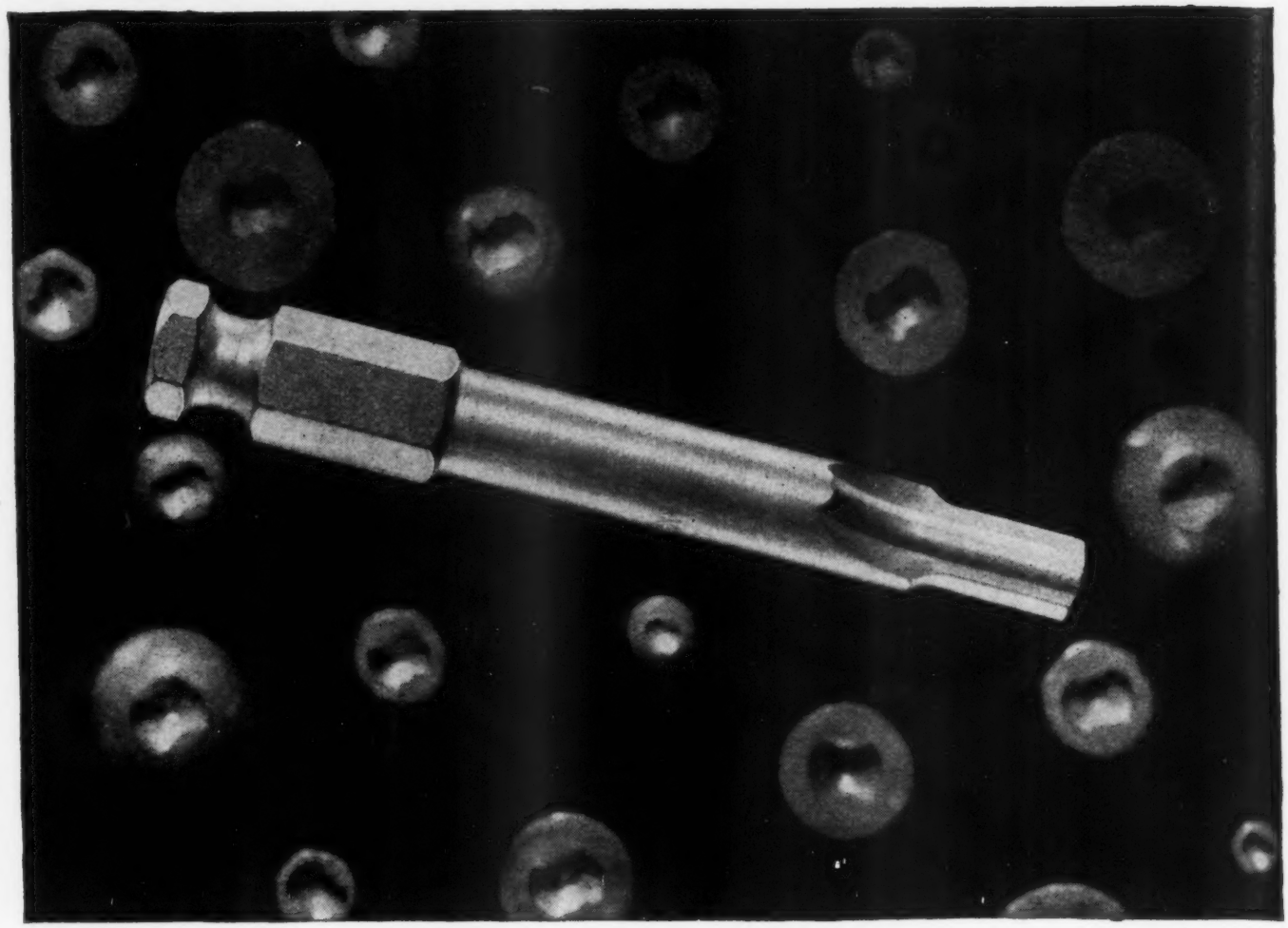
Manufacturers of wartime heat exchangers discovered this early, using furnace-brazed aluminum to obtain highest heat-transfer efficiencies. And they made extremely complicated assemblies which could not have been made by other methods.

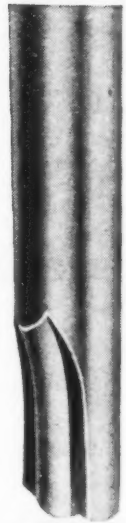
Pictured above, you see aluminum tubing furnace-brazed to aluminum sheet, much as you might assemble a refrigerator evaporator, or condenser. Tubing and sheet are bonded into a single, solid unit by an aluminum alloy.

Does this suggest things to you? Alcoa's engineers can help you put your ideas into practice. ALUMINUM COMPANY OF AMERICA, 2193 Gulf Building, Pittsburgh 19, Penna.

ALCOA FIRST IN ALUMINUM

ALCOA ALUMINUM





How Many Thousands of Screws Per Bit?

CLUTCH HEAD users have the answer to this question . . . for that is how they measure the economy and efficiency of screw driving on their assembly lines.

The explanation of this unequalled "high-score" driving is simple. It lies in the ruggedness and design of the Type "A" Bit. This ruggedness is self-evident and is made possible ONLY by the mating design of the Clutch recess. This means stamina to stand up through a longer driving spell, free from tool change interruptions . . . speeding up the production tempo and rolling up the record of thousand upon thousand of extra screws per bit.

Note, too, that the driving score of this bit is multiplied time and time again because it may be repeatedly restored to original efficiency by a 60-second application of the end surface to a grinding wheel.

Other special features incorporated in CLUTCH HEAD *Screws contribute importantly to greater safety, higher production, and lower costs. We invite your personal investigation of these and will send you,* BY MAIL, *package assortment of* CLUTCH HEAD *Screws, sample Type "A" Bit, and illustrated Brochure.*

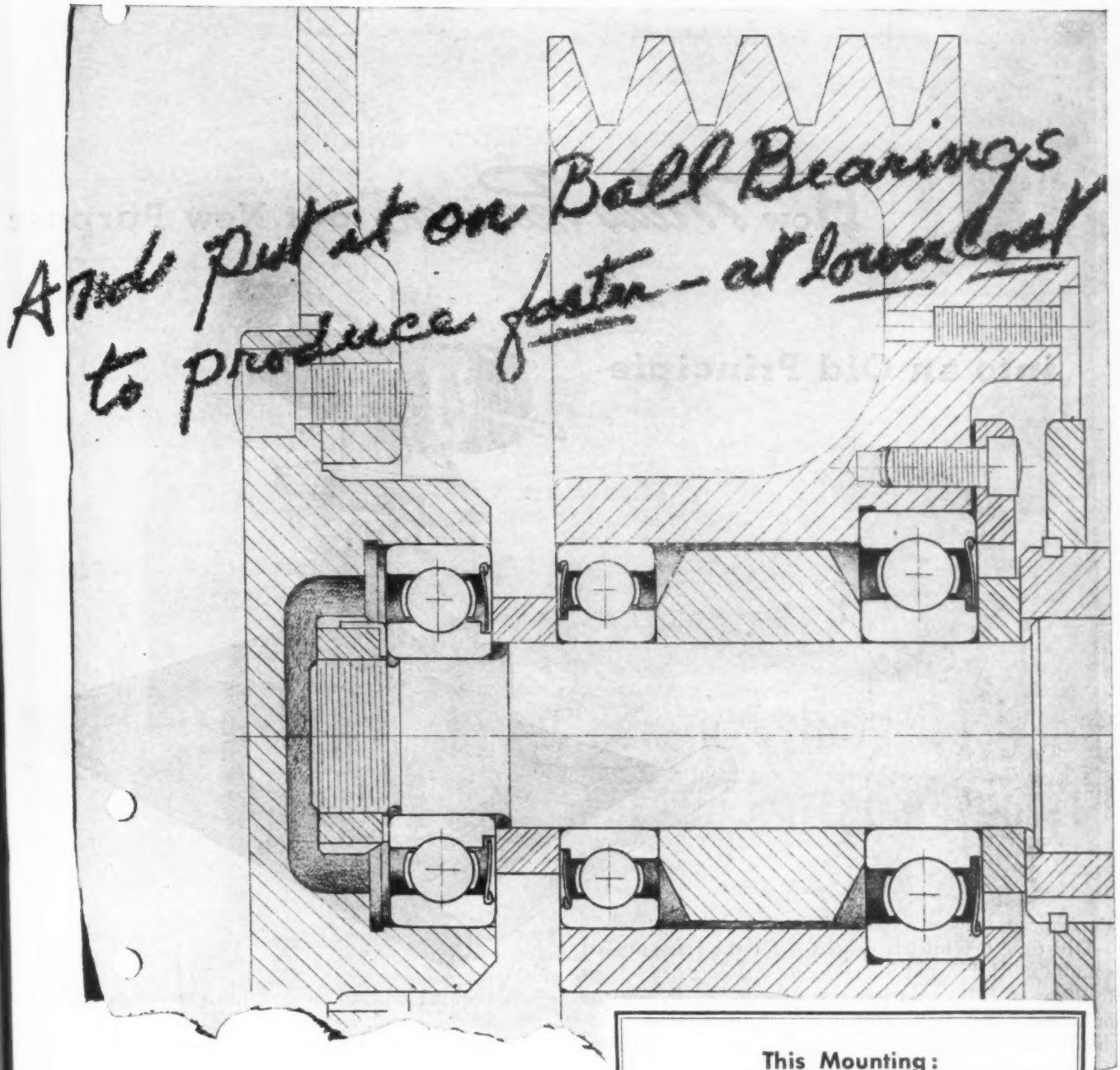
Being operative with an ordinary screwdriver or any flat blade of reasonably accurate width, this is THE ONLY MODERN SCREW *that simplifies your field service problems.*

CLUTCH HEAD SCREWS

Note the straight-walled Clutch matched by straight-sided driver for square engagement, eliminating "ride-out" tendency with hazard of slippage as set up by tapered driving.

UNITED SCREW AND BOLT CORPORATION

CHICAGO 8 CLEVELAND 2 NEW YORK 7



WHEN the war is won, ball bearings will help to bring sound, simplified design and lower maintenance expense to countless new machines of every kind.

And on the production lines, ball bearing equipped machines will produce faster, better and at lower cost for the peace needs of industry, even as they are now setting world records in quantity and quality of goods for war.

This is one of a series of bearing mounting designs. Others of the series will be sent upon request.

NEW DEPARTURE
BALL BEARINGS

This Mounting:

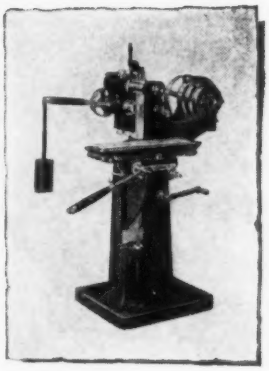
Ball bearing designs need not be complicated to be efficient or capable of long service with little attention.

This Lathe Pulley mounting merely follows the simple fundamentals of ball bearing application, yet it assures trouble-free operation at any speeds at which the machine can be run. And, maintenance is just about zero.

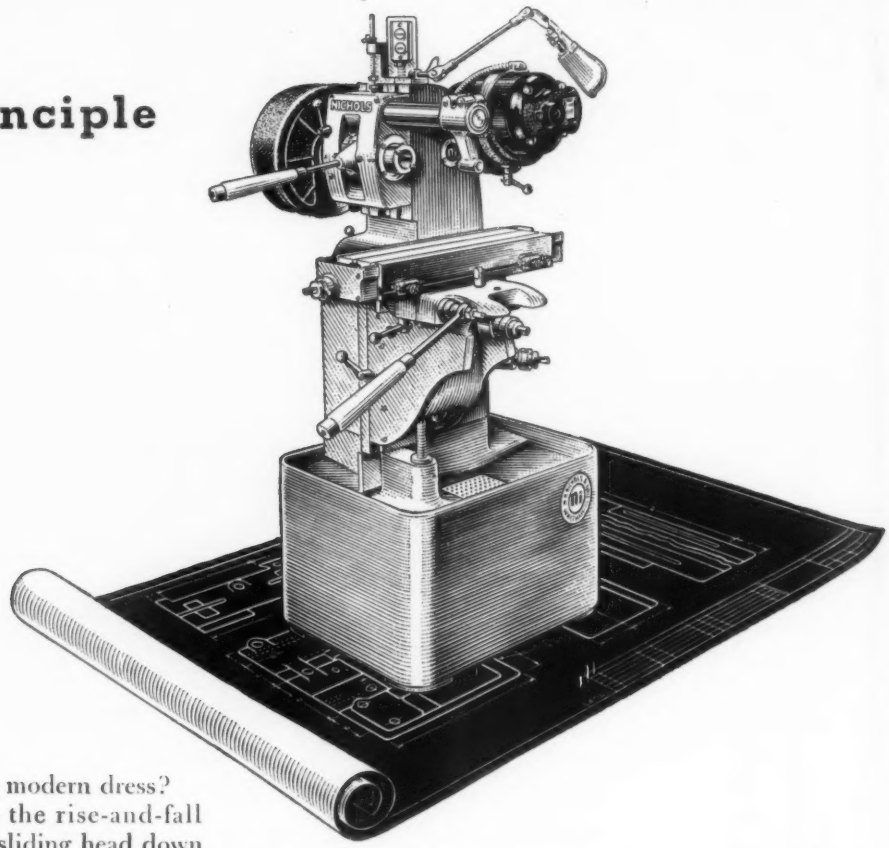
Note: 1. Machining for pulley bearings is all from one side. 2. Spacer between bearings leaves room for only such grease as will actively lubricate. No waste. 3. It is shaped to keep grease in good condition and in the bearings. 4. Narrow spacers at ends of pulley extend well beyond shield notches in bearings—give more efficient closures.

NEW DEPARTURE • DIVISION OF GENERAL MOTORS CORPORATION • BRISTOL, CONNECTICUT

Sales Branches: DETROIT, G. M. Bldg., *Trinity 2-4700* • CHICAGO, 230 N. Michigan Ave., *State 5454* • LOS ANGELES, 5035 Gifford Ave., *Kimball 7161*



How *Mass-Precision* put New Purpose into an Old Principle



Recognize this famous old miller in its modern dress?

Old-time machinists valued it for the rise-and-fall spindle which brought the cutter on a sliding head down to the work. This principle was new and basic, and the miller enjoyed many years of success. With accelerated production, however, industry demanded greater versatility, rigidity and accuracy in its machines. Operating men began to label the miller a "has-been"...until Nichols decided to *mass-precision* it.

The engineering insight of "Accurate" Nichols appraised its many advantages and foresaw its almost unlimited possibilities for the toolroom as well as the production line. Thorough redesign gave it new purpose and precision manufacture gave it the accuracy necessary to keep pace with mass-production "musts."

You'd hardly know the old miller now. The spindle is hardened and is equipped with roller or ball-bearings. Solid gibs, box-type saddle and head, counter-balanced motor drive and rapid-action rack and pinion saddle motion have been added...all merged into a compact, multi-purpose machine tool.

Today you can see it performing dozens of different high-speed machining operations on production lines and toolrooms everywhere...*to tolerances in "tenths."*

Your engineering and production problems may be far afield from machine tools, but Nichols' ability and manufacturing facilities may put *new purpose* into one of your reconversion blueprints.

Nichols-built products draw upon the most advanced manufacturing techniques and facilities, including lapping, grinding, hole locating and sizing, plus precision testing methods to affirm their accuracy.

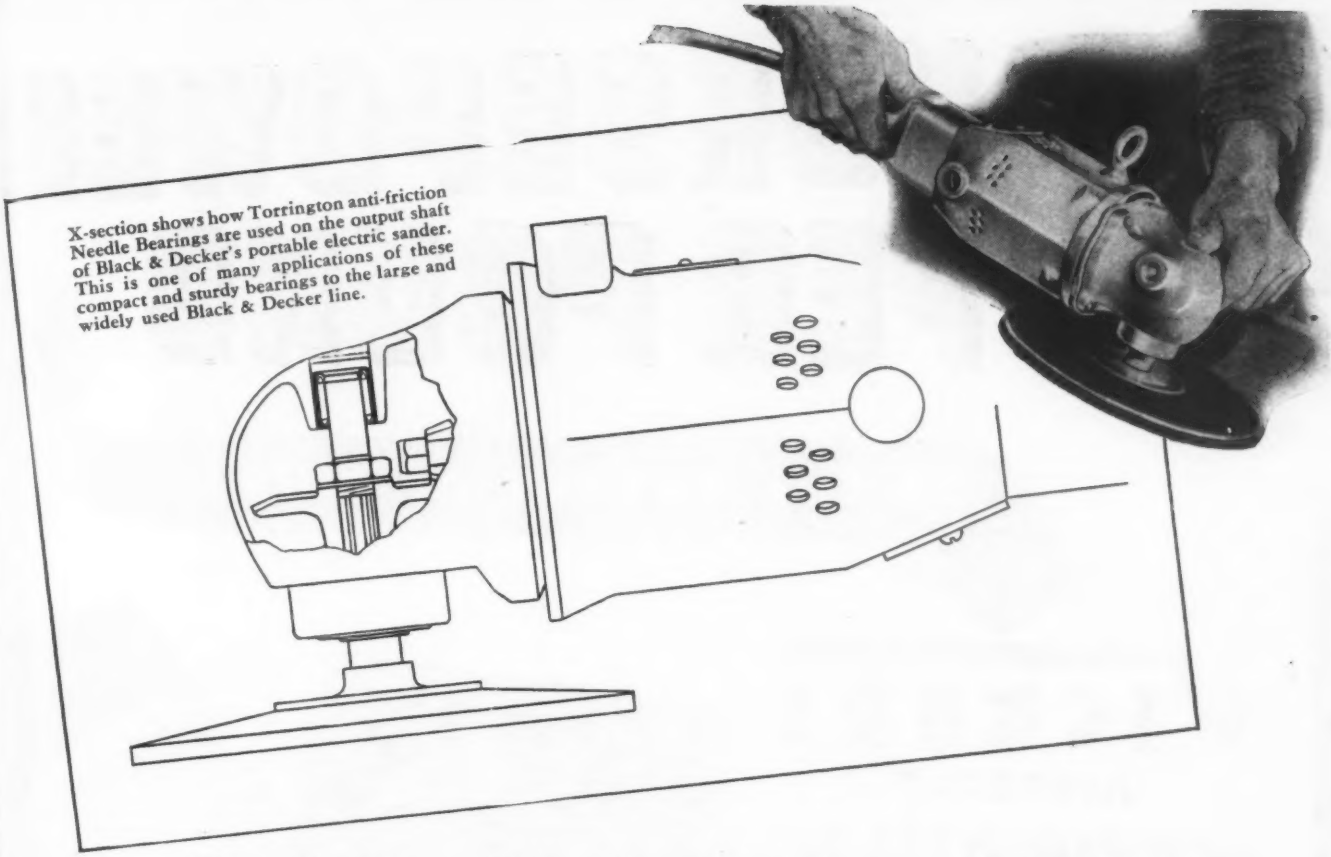
Put your problem up to "Accurate Nichols."

W. H. NICHOLS & SONS, 48 WOERD AVENUE, WALTHAM 54, MASS.

"Accurate" *Nichols*

ni

PRECISION ENGINEERING AND MANUFACTURING FACILITIES FOR MASS-PRODUCTION



X-section shows how Torrington anti-friction Needle Bearings are used on the output shaft of Black & Decker's portable electric sander. This is one of many applications of these compact and sturdy bearings to the large and widely used Black & Decker line.

Torrington Needle Bearings Help Design and Performance of Portable Tools

Portable tools must be engineered to deliver peak performance on continuous, heavy-duty production or maintenance work under the extremes of service conditions. Typical is Black & Decker's light, compact, rugged portable electric sander, shown above, widely used for sanding metal, wood, stone or tile.

Typical, also, is the fact that output shaft uses anti-friction Torrington Needle Bearings. You'll find them on the job on other Black & Decker tools, too . . . and on the tools and machinery of an amazing variety of trades and industries. That's because these light, compact bearings help simplify design . . . stand up to prolonged usage . . . are easily lubricated . . . help turn out more, better, and faster work.

In designing or buying tools or machinery, it will pay you to have clearly in mind the advantages of Torrington anti-friction Needle Bearings . . . to know how they can help *your* equipment turn in a better job. Torrington's Needle Bearing Catalog No. 30-A is packed with data on types, sizes, performance and applications to a wide range of tools and machinery. Write for it today.

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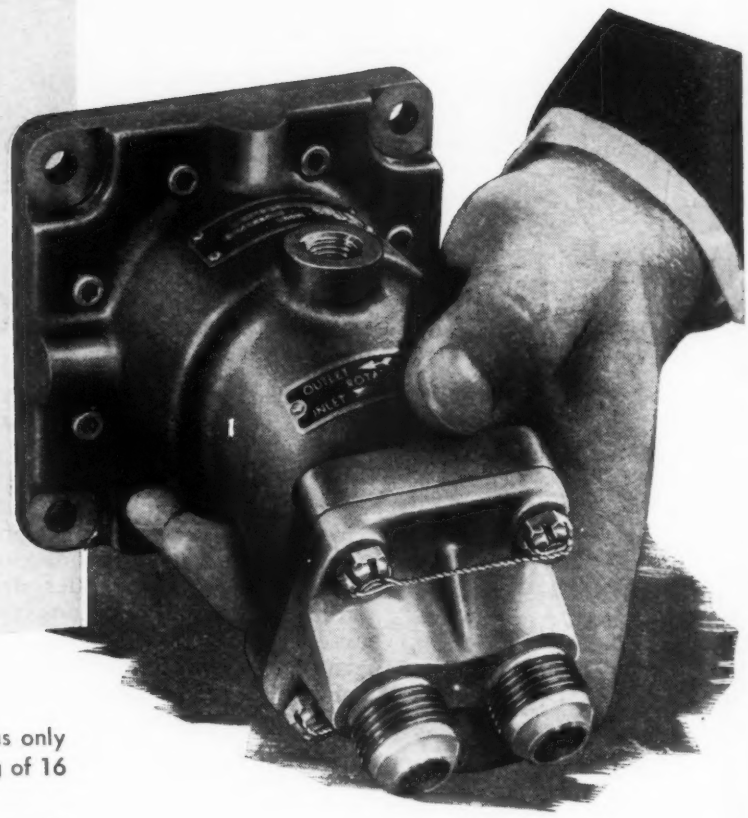

This Vickers Aircraft Hydraulic Motor weighs only 6.4 pounds yet it has a normal output rating of 16 horsepower at 3000 psi and 3750 rpm.

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Whether designed primarily for aircraft work or for flexible power transmission and control in industrial installations, Vickers Piston Type Hydraulic Motors are inherently simple and rugged, with resulting minimum maintenance; they are easy to install and widely adaptable. All of these characteristics suggest many applications to a wide variety of new postwar equipment.

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PRODUCT ENGINEERING

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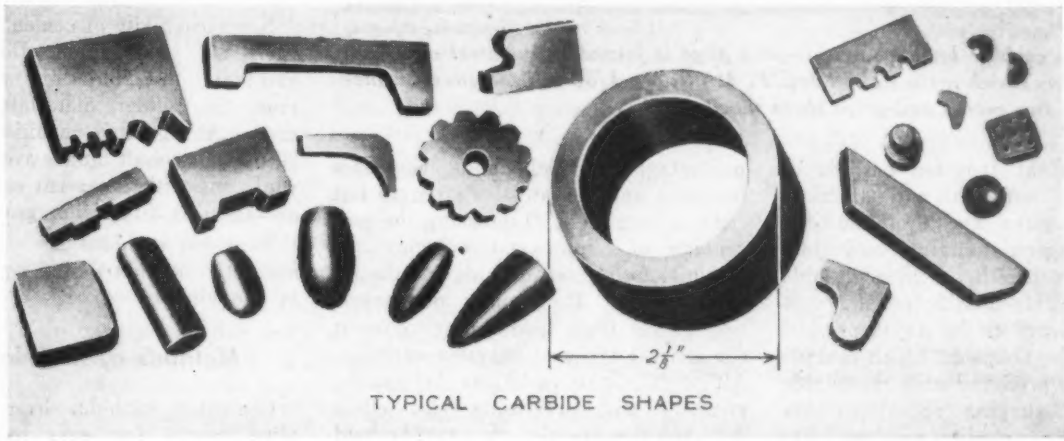


TYPICAL CARBIDE SHAPES

Effect of Cemented Carbides On Product Design

HARRY CRUMP, *Assistant to Vice President*
PAUL MILLER, *Development Engineer*
Carboloy Company, Incorporated

Presenting with examples the many possibilities in the use of cemented carbides for improving product design by increasing the life of parts. Physical properties and methods of attaching carbide parts to base materials are outlined.

THE success of carbides in the form of cutting tools and dies is largely the result of their extreme hardness, wear resistance, and compressive strength. These properties, combined with the new shapes of cutting tools, which have been developed recently, permit enormously increased speeds when machining all kinds of materials; give longer retention of accuracy; and have greatly lowered machining costs. Even more important, perhaps, carbide tools have greatly expanded the entire range of economically machinable materials. These added materials include highly abrasive silicon aluminum alloys, now used for pistons; extremely tough centrifugally cast irons, now used for brake drums; cast alloys of cobalt; the toughest grades of stainless steels; tough steels such as cast armor plate; extremely tough or abrasive nonmetallics including asbestos compounds plastics, and ceramics. Thus the carbides have widened the scope of product design possibilities.

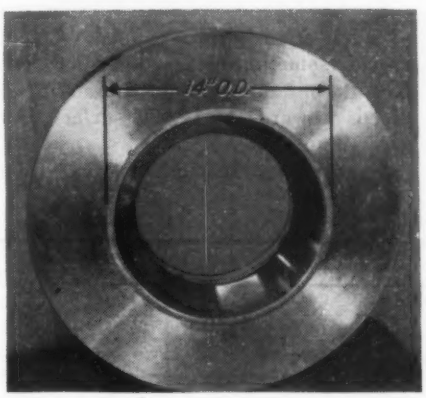
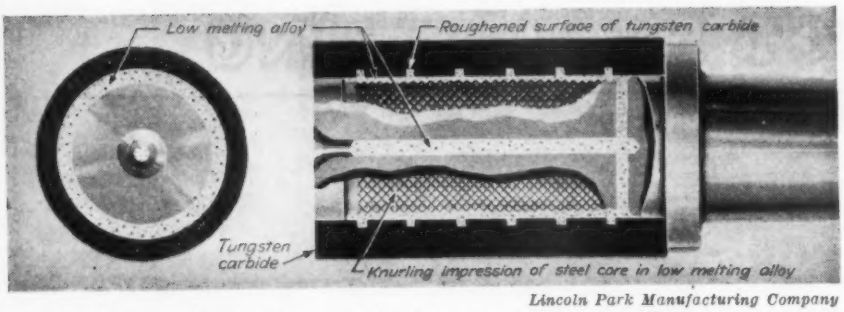


Fig. 2—The carbide insert for this die for deep drawing heavy gage steel gas containers weighs 105 lb., close to present practical weight limit for carbide parts. Carbides have proved much more economical in such applications.

The same unusual properties and combinations thereof, which have brought carbides to the forefront in cutting tools and dies, are bringing this metal into rapidly increasing use for mechanical parts. In addition, the carbides are highly resistant to erosion and many forms of corrosion. Another factor that often favors the use of carbides in product design is that many of the physical properties can be varied by modifications in the compositions and methods of producing the carbides.

Carbide parts are made from metal powders by pressing and sintering, much the same as in making powder pressings of other metals. The powders


Low melting alloy
Roughened surface of tungsten carbide
Tungsten carbide
Knurling impression of steel core in low melting alloy

Lincoln Park Manufacturing Company

Fig. 3—The carbide bushing of this plug gage is joined to the steel core with a special alloy which melts at 250 deg. F. It fills the 1/32 to 3/32 in. clearance between the two pieces and grips them mechanically.

may be straight tungsten carbide or mixtures of tungsten and titanium carbides, tungsten and tantalum carbides; or tungsten, tantalum, and titanium carbides, together with a suitable binder, which is usually cobalt.

There appears to be no theoretical limit as to the shape in which carbide parts can be produced at a reasonable cost. Some shaping operations can be done after pressing and semi-sintering but before final sintering. Carbide metal is now available for general use at a cost per pound 1/20th that of 15 years ago. As in any new development there do exist, however, at least temporary practical commercial limits as to size, which are determined primarily by available press capacity. At present, solid carbide metal parts with a 100 sq. in. top surface area can be formed readily, although the shapes of such large parts must fall within an 18-in. circle. Maximum practical thickness, regardless of other dimensions, is limited currently to approximately 8 in. The practical weight limit, considering these dimensional limitations, is between 100 and 120 lb. At the other dimensional extreme, carbide parts as small as the point of a lead pencil are produced to extremely close tolerances.

Within certain limits, the physical properties of carbides can be controlled by varying the percentages of the various ingredients. Thus, all other things being equal, increasing the percentage of tungsten carbide and decreasing the percentage of cobalt binder increases hardness and compressive strength but reduces toughness. Increasing the percentage of binder and reducing the amount of tungsten carbide has the reverse effect. The ranges of properties, as set forth below, cover current commercial types of tungsten carbides. Although slight variations in powder mixtures and processing also effect mechanical properties, they can be held close enough to make deviations from desired properties negligible.

Physical Properties

At normal temperatures the hardness of tungsten carbides is somewhat less than that of diamond, about equal to that of silicon carbide, and greater than that of such abrasives as aluminum oxide. Penetration hardness is 85 to 93 Rockwell A using a 60-kg. load. Abrasive or scratch resistance ranges between 9 and 10 on Moh's scale.

At a temperature of 1,550 deg. F., tungsten carbide has a hardness about equal to that of high-carbon tool steel at 650 deg. F or high-speed steel at 825 deg. F. This high "red hardness" of carbides, in conjunction with a new conception of tool and machine design, has made possible the milling of steels with carbide tipped tools at speeds sometimes exceeding 500 surface ft. per min. and of aluminum at speeds upwards of 12,000 surface feet per minute.

Compressive strength varies from 600,000 to 900,000 lb. per sq. in.

Impact strength, obtained from ¼-in. square specimen, unnotched, ranges from 0.40 to 1.75 ft. lb. on Charpy machine.

Thermal expansion averages about half that of steels. Coefficient of linear expansion at 68 to 1,290 deg. F. is between 2.8 and 4.2×10^{-6} for different carbides.

Specific gravity of cemented carbides varies with composition. Both tungsten and tantalum carbides are much heavier than the binder materials generally used. A cemented carbide containing 20 percent cobalt binder averages 13.55 while one with 3 percent cobalt binder averages 15.25 specific gravity.

Tungsten carbides are only slightly magnetic, as contributed by the cobalt in the binder.

Methods of Attachment

Cemented carbides have been applied mostly for wear resistance by brazing a comparatively small "insert"

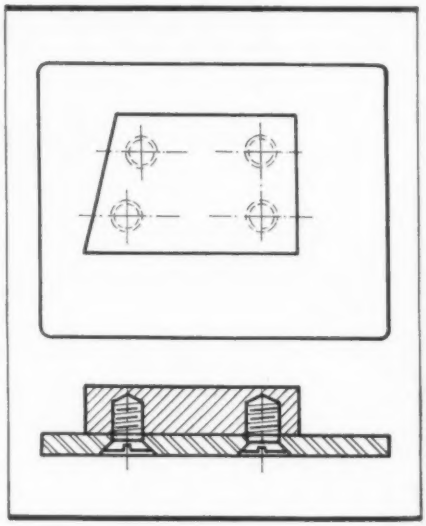


Fig. 4—Carbide plates sometimes can be attached by means of screws or bolts. Such attachments reduce the "wear surface" by the area of the holes for screw or bolt heads.

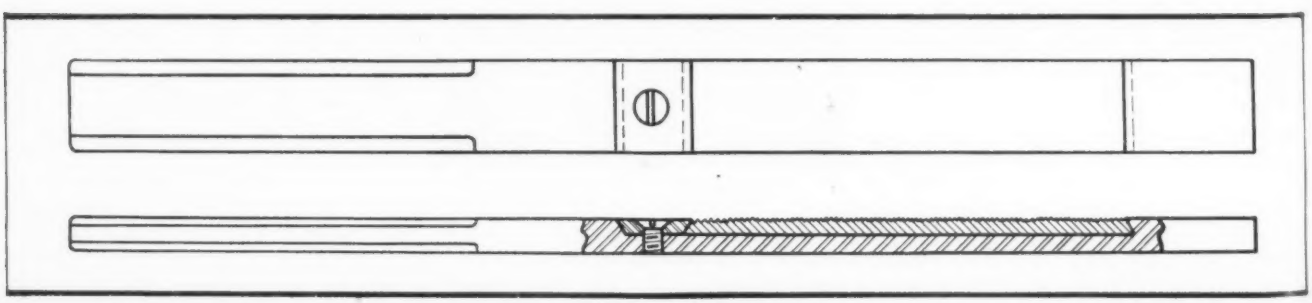


Fig. 5—Many forms of clamps can be used to attach carbide inserts. In the above assembly clamping action depends on the beveled ends of the carbide insert and recess. Quick replacement is possible.

such as a plate, liner, sleeve, bushing, or shoe to a steel shank or base, which may be flat or recessed to receive the insert, at the point or points where wear is to be prevented. The usual brazing materials are silver solder or copper.

Where brazing cannot be used because of high brazing temperature, strains set up, design considerations, or other reasons, the following methods of attachment can be used, depending upon the conditions of production and service that are involved.

SHRINKING OR PRESSING carbide inserts into a metal base is often satisfactory for round pieces but less practical for rectangular inserts. Low thermal expansion of carbides usually makes it more practical to heat the base metal than to freeze the carbide insert.

CEMENTING is usually satisfactory for attaching carbide inserts to wood or plastic bases, or other materials that cannot be brazed readily. A vinyl resin plastic bond gives about the same order of strength as the average solder when applied on the bottom and sides of the recess.

SOFT SOLDERS have proved satisfactory when the temperature of operation is not too high. They are economical and easy to apply, although most grades of carbides should be nickel plated so that the metal will "take" the solder.

LOW MELTING POINT ALLOYS are practical in some instances where even the low heat of soldering may injure the part. The carbide plug gage shown in Fig. 3 is so made.

SCREW OR BOLT ATTACHMENT, illustrated in Fig. 4, reduces the "wear surface" by the area of the holes. Screw holes must be put in carbides before sintering since it is not yet practical to thread carbide. Screw threads can be made of a coil of wire brazed in place and tapping to form threads. When screws or bolts are used, the fit between carbide and base material should be close to prevent internal strains when non-uniform loading results from tightening.

CLAMPS have many design possibilities. Fig. 5 is only one example.

Wear Resistance

There are no recognized tests that give numerical values of wear resistance or that are applicable to the innumerable different conditions under which wear takes place. A more definite picture of the wear resistance of tungsten carbides as compared to other materials subjected to the same conditions is obtained by comparisons of performance. The examples given below are arranged for convenience into four general types of service: Mild wear conditions, extreme wear conditions, wear complicated by other factors such as corrosive conditions, and wear under pressure. These case histories from different fields of application are cited to serve as guide posts to design engineers in using the various properties of carbide metal in designing new, or improving old, products.

The advantages of carbide metal in resisting wear are not limited to applications where conditions are severe. In some instances, wear of a few thousandths of an inch has serious consequences. Both small inserts or tips and solid parts of carbide metal are used in this class of service. Examples include gages and gage support mounting fixtures, where the metal's ability to take and retain a surface finish of a high degree of smoothness is also valuable.

Another excellent example where a slight degree of wear at a vital point destroys the accuracy of the entire machine is in the throat block of the tabulating machine printer, shown in Fig. 6. Here, wear is produced by paper cards, a "soft" material.

Bearings are another example of

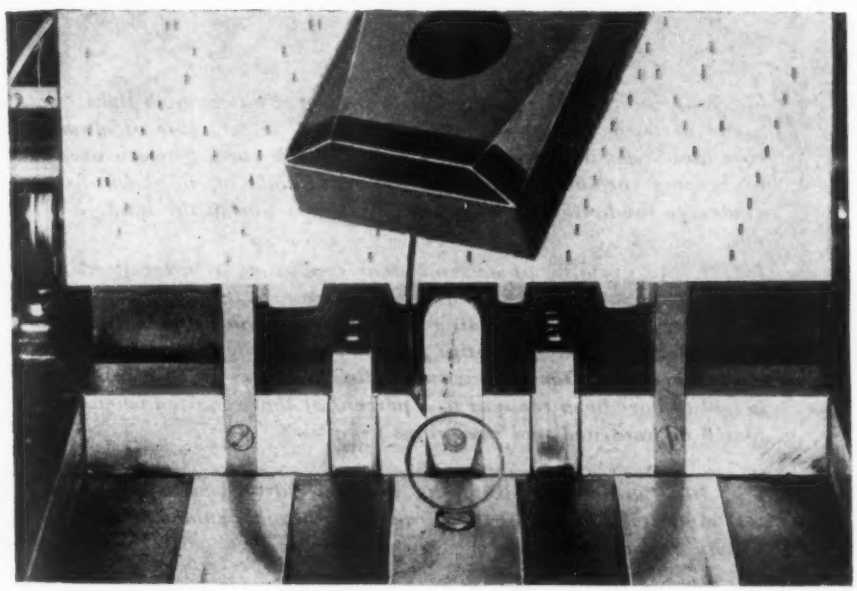


Fig. 6—In this tabulating machine printer, wear of only 0.003 in. on the "throat block" disrupts operation of the whole machine by permitting passage of more than one card. Wear produced by the "soft" paper cards necessitated replacement every 30 days. When blocks were tipped with carbide, no sign of wear could be detected at the end of 6 months.

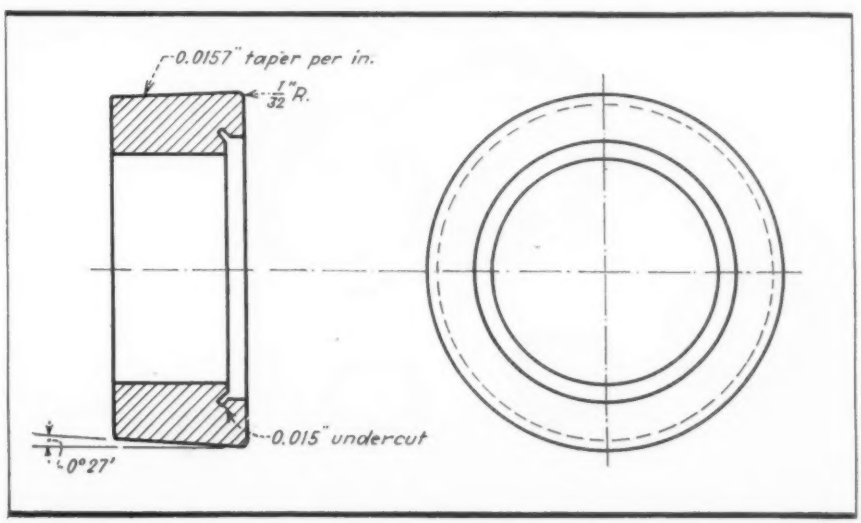


Fig. 7 (Right)—Carbide roll used in steady-rest and guide fixture for long work pieces on automatic screw machines where uniformity of wear is vital. Service life was said to be increased 400 times. Rolls withstand accidental shock of shearing through bar.

mild wear conditions. Cemented carbides are being used for bearing sleeves and facings. In one plant, sleeve type carbide bearings were substituted for hardened chrome steel ball bearings that lasted only three weeks in portable flexible-shaft grinders operating 16 hr. a day at 10,000 to 15,000 r.p.m. The shafts are also bushed with a slightly different grade of carbide. Thus both bearing surfaces are of solid carbide. When last checked the carbide bearings had been operating satisfactorily for more than eight months. The successful use of cemented carbide in this application is of course at variance with the accepted concept of bearing design, that one metal should be considerably softer than the other. Here both surfaces are extremely hard.

Burnishing wheels used to impart a fine finish to watch and instrument parts as small as 0.004 to 0.005 in. dia. consist of 1 to 3-in. dia. wheels with carbide rims $\frac{1}{4}$ to $\frac{3}{8}$ in. wide, into which thousands of minute teeth have been produced by an abrasive wheel.

Some other typical applications of cemented carbides where the wear is relatively mild are lathe ways, lathe and grinder centers, lathe work and follow rests.

Extreme Wear Conditions

Carbides are particularly effective in minimizing the effects of wear under extreme conditions, which may be caused in two ways: by abrasives and by concentration of wear or friction by relatively soft materials. In both types of service carbides are being used in the form of complete parts, as inserts in parts, and as specially designed smaller parts included in large assemblies. Carbide parts are usually designed and placed in such a manner that they will bear the entire brunt of the wearing action, thereby making it possible to construct the remainder of the assembly of less costly material.

For example, tool steel knives on sewing machines used to make camouflage netting, a tough, highly abrasive fabric that is chemically treated, wore away almost immediately after installation. When solid carbide knives of identical design were substituted they functioned for days without noticeable dullness.

Another application, which is representative of conditions where wear is severe and concentrated, is the guides on machines for winding Nicrome wire on electric resistor tubes. On these machines carbide guides and wear parts increased the operating time between shut-downs from one day to several months. Such guides have also proved valuable on fishing rods, wire stranding machines, and textile machines.

Other typical applications are parts for grinders used on paint pigments and other abrasive materials, brick mold liners, and core box feet. Figs. 8, 9 and 10 show some examples of parts for extreme wear.

Wear Complicated by Other Factors

Frequently parts exposed to wear are subjected also to other conditions that tend to accelerate wear. Here the com-

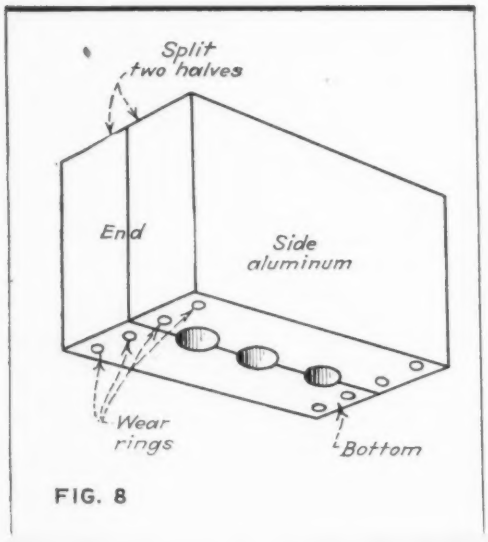


FIG. 8

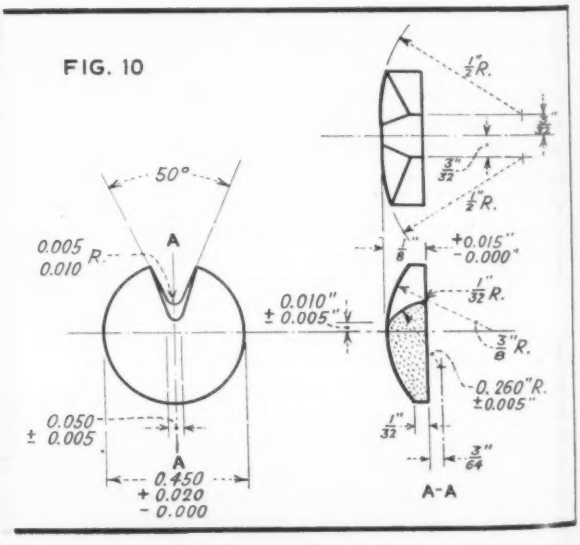
Fig. 8—Use of small carbide inserts at critical points gives light, "soft" metal parts the wear resistance of a "hard" metal. Life of aluminum core boxes was increased from 1,500 to 9,000 cores between overhauls by brazing carbide rings, which were originally intended for fish rod guides, to the bottoms to take the abrading action of the sand.

Fig. 9—An example of extreme wear conditions of a localized rather than a general nature. Strands of fine wire pass through these rings at high speeds on wire stranding machines. In this instance it is more economical to make the entire part of carbide than to attach an insert to the steel ring. Down time of stranding machine for ring replacement is said to have been reduced to 1 percent of that required when chrome plated or hardened tool steel rings were used.

Fig. 10—Carbide guides taking the concentrated wear produced by soft materials like rayon thread passing through guides at fairly high speeds outlast hardened and chrome plated steel rings many times.

FIG. 9

FIG. 10



bination of high hardness, strength, resistance to certain types of corrosive materials, along with wear resistance, has served to prolong the life of equipment. Among parts for which carbide metal has been used in this type of service are valve seats, valves and nozzles of many types.

Regulating valves for molten aluminum were rendered useless so quickly that the problem was subjected to intensive investigation. As a result the valves for this extremely corrosive and erosive service are now made of carbide and are reported to be lasting at least 150 times longer than the heat resisting valves previously used.

Spray nozzles for dehydrating fruit juices were made of carbide after stainless steel, hardened tool steel, and even chrome plated brass had been tried. Under this corrosive condition life expectancy is reported to have increased at least 100-fold. Other corrosive conditions are also being withstood by carbide spray nozzles or valves for milk, liquid cement, blood, ammonia, and fire-fighting equipment. Figs. 11 to 13 show some other types of carbide nozzles and valves now in use.

Wear Under Pressure

Wherever wear resistant parts are subjected to heavy loads, carbides are particularly applicable because of their strength and extreme hardness. The forms that carbide parts may assume for such duty are of wide variety. Brinell balls of tungsten carbide are not only giving longer service than steel balls, but also truer readings because their hardness and compressive strength exceeds that of the hardest steels on which they are used.

Ball bearings have been made of carbide experimentally. Preliminary indications are that they will outlast chrome steel balls many times under certain service conditions, it is reported. Carbide balls are now being used successfully for supporting heavy moving tables on such machine tools as large planers and grinders. Both compressive strength and abrasion resistance are essential for this service.

Cutting tools and tools for preparing surfaces for metallizing are parts that must withstand this class of service. Fig. 14 shows a related application.

Although the economies of incorporating carbides into product design are not easily evaluated, it can be stated safely that the initial cost is now frequently of little moment when compared with advantages obtainable. Protective inserts are giving way in some instances to whole parts made of the material as a result of greatly decreased costs of material in the past 15 years.

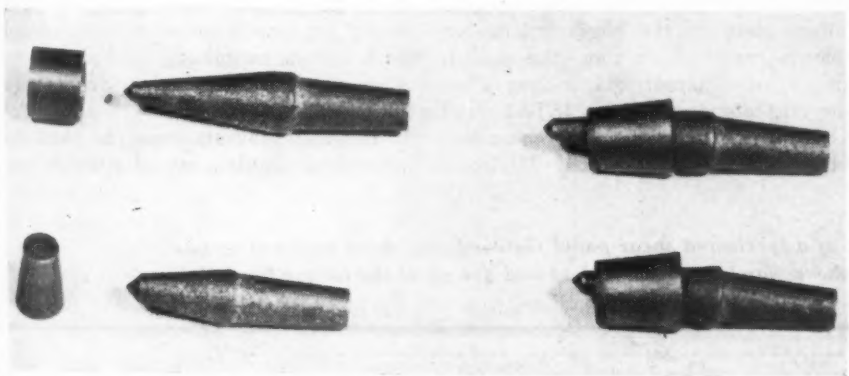


Fig. 11—Excessive erosive wear, as in nozzles for spray painting, can be prevented by using carbide for the nozzles. This problem was particularly troublesome with equipment used for marking lanes on streets and highways because of the abrasive silica in the paint.

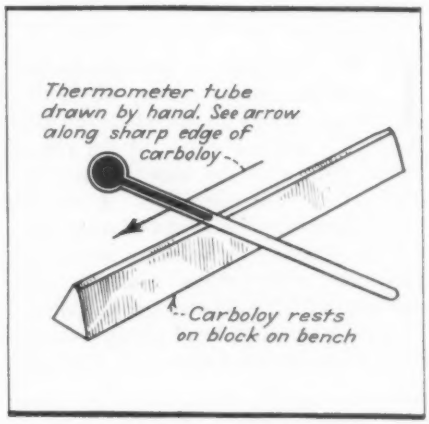


Fig. 14—Freezing and boiling point marks on glass thermometer tubes were once made with special files and later with razor blades, which were better but lasted only a few minutes. Now the thermometer tube is drawn along a section of carbide, ground to a fine edge. This makes a finer, smoother line than either files or razor blades and lasts for weeks instead of minutes.

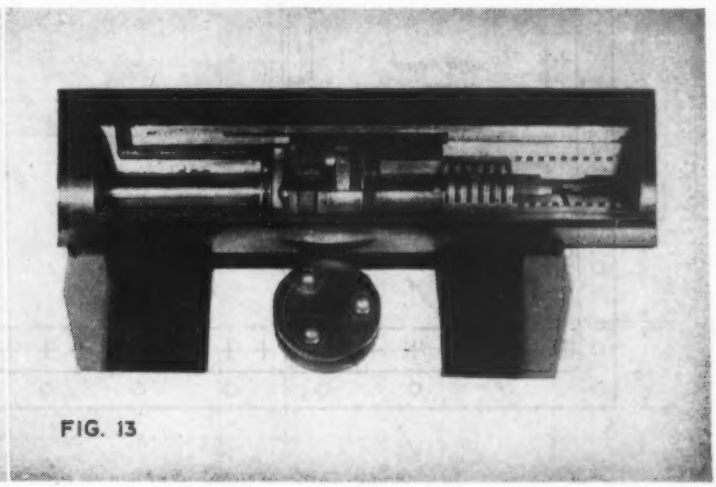


Fig. 12 (Left)—Carbide needle and nozzle for this lacquer spray gun, subject to erosive wear, increased life from 800 hours maximum to as long as two years of almost continuous 24-hours-per-day operation. Fig. 13 (Right)—Valves for oil well pumps are subjected to severe erosion when the oil and water contains sand. Carbide ball and valve seat inserts increased the operating hours of pumping equipment.

Fatigue Failure in Shear Panels Of Aluminum and Magnesium Alloys

E. R. SCHENKEL
Development Test Engineer
Consolidated Vultee Aircraft Corporation

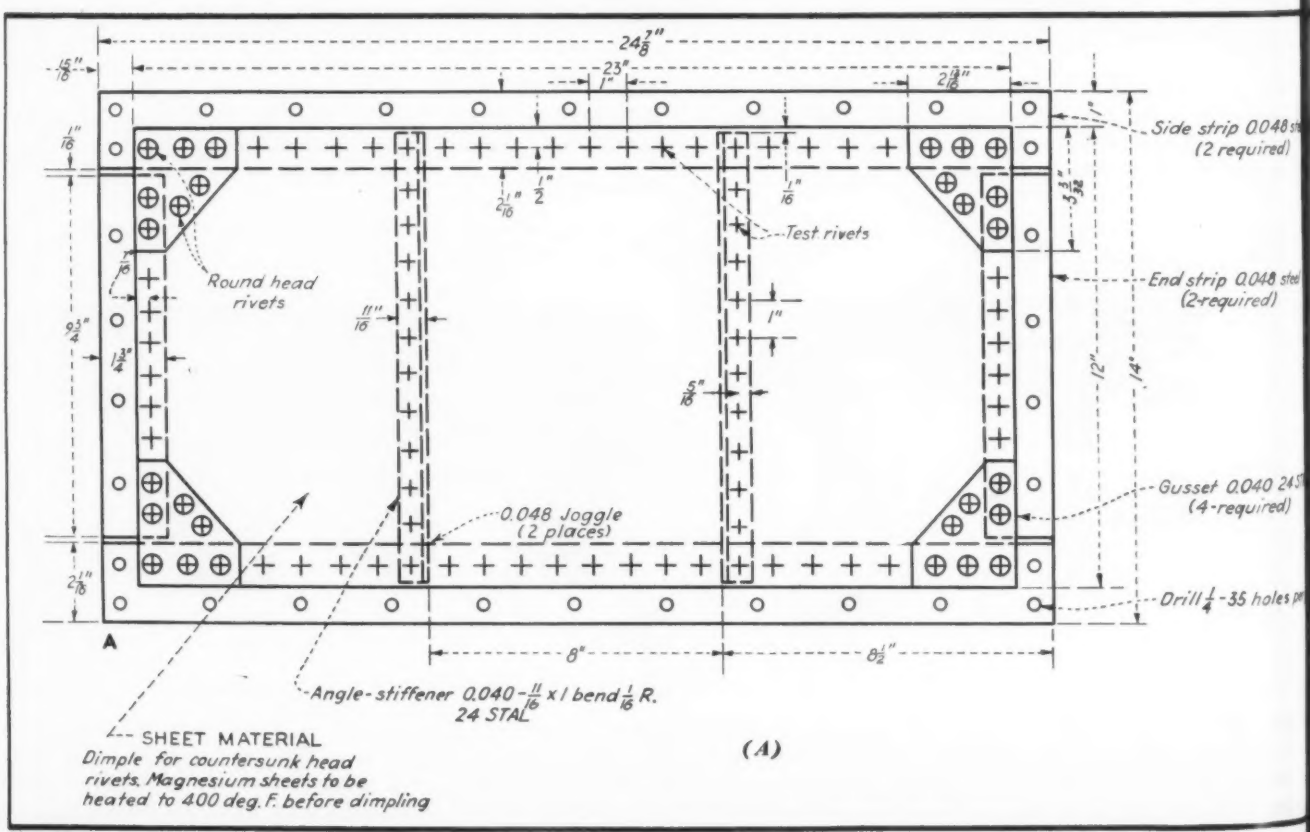
A comparison of the shear fatigue life of aluminum and magnesium alloy panels fabricated with various types of rivets used by the aircraft industry. Results are presented in chart form to allow the designer to evaluate quickly the fatigue characteristics of these rivet and alloy combinations in certain applications.

It is necessary to use the proper working stress when designing shear panels to be made of thin light alloy sheet because of the rather brittle nature of the material and the high stress concentrations developed by notches, scratches and similar conditions. The specific working stress will vary with the particular alloys used and also with the type of joint construction, such as round-head rivets, countersunk rivets, dimpled rivets and Metbond.

To establish data for the design of shear panels of adequate fatigue strength, a series of tests was instituted by engineers of the Consolidated Vultee Aircraft Corporation. The test program was set up to obtain specific fatigue data on the characteristics of various types of riveting, the acceptability of different magnesium alloy sheets, comparison of 24STAL and XB75STAL aluminum sheets, characteristics of Metlbond joints, Metlbond when used in the form of reinforcement strips in conjunction with machine countersunk rivets and the effect of improperly driven rivets. Metlbond and four rivet types, NACA countersunk, flush dimple, machine countersunk and round head, were tested in combination with various magnesium and aluminum alloy sheets varying in gage from 0.010 in. to 0.040 in.

The test program required that the procedure simulate actual aircraft con-

Fig. 1—Test pieces consist of a fabricated shear panel fastened to a shear resistant torque box. Design of removable shear panels is shown at (A) and design of the torque box, (B).



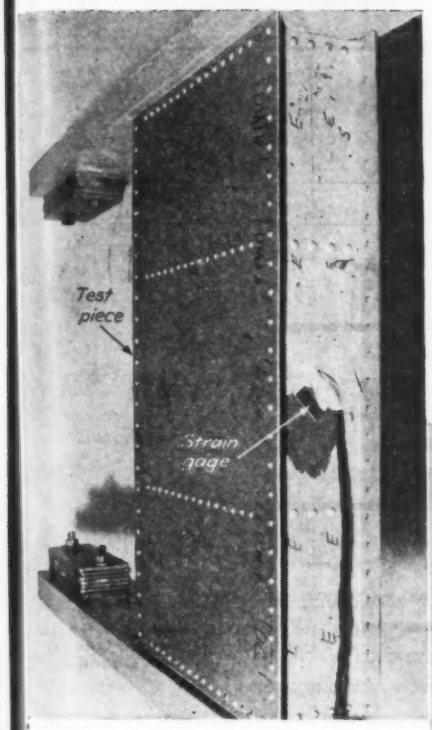


Fig. 2 — Method of mounting strain gage on the test piece to maintain exact panel loading while test is in progress.

ditions of structure and loading and thus furnish a means to evaluate relatively the fatigue data obtained. The apparatus was designed to be vibrated at the natural frequency of the test piece, and to produce a reversing shear load that would be uniform throughout the panel.

Test pieces were of two designs. Both designs consisted of a torque box to which the shear fatigue test panels were either riveted or bolted. The design with bolted or interchangeable panels was used for all tests of material and rivet combinations. The design having panels riveted to the torque box was used for special tests where interchangeability of the panels was not desirable.

The test apparatus was suspended by a cable at the center line of rotation of the test piece. Two steel channels were fastened to the test piece and a mechanical vibrator attached to one end of the lower channel to produce the desired load moment arm. Weight slugs

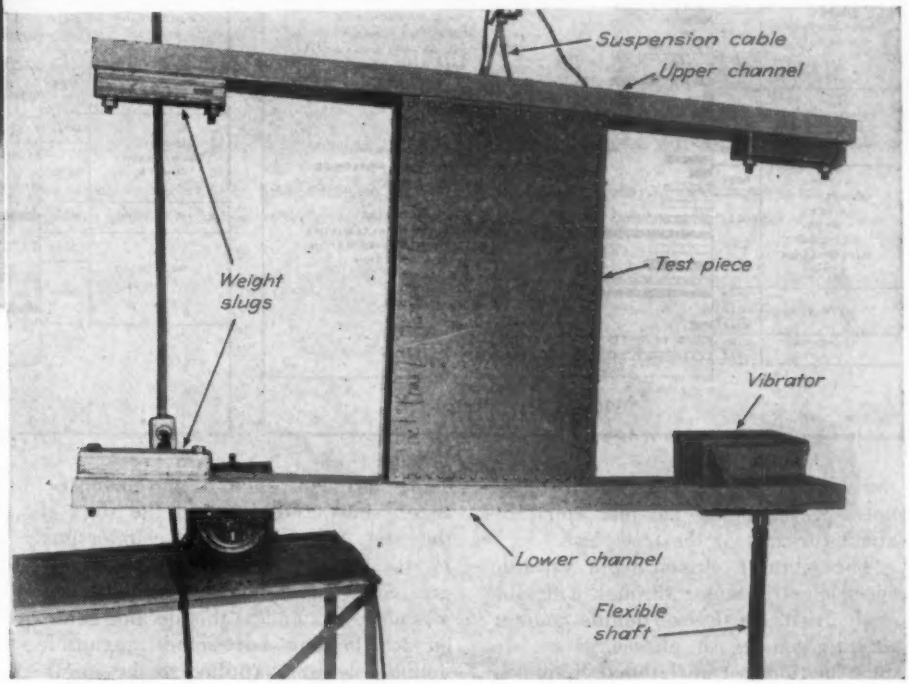
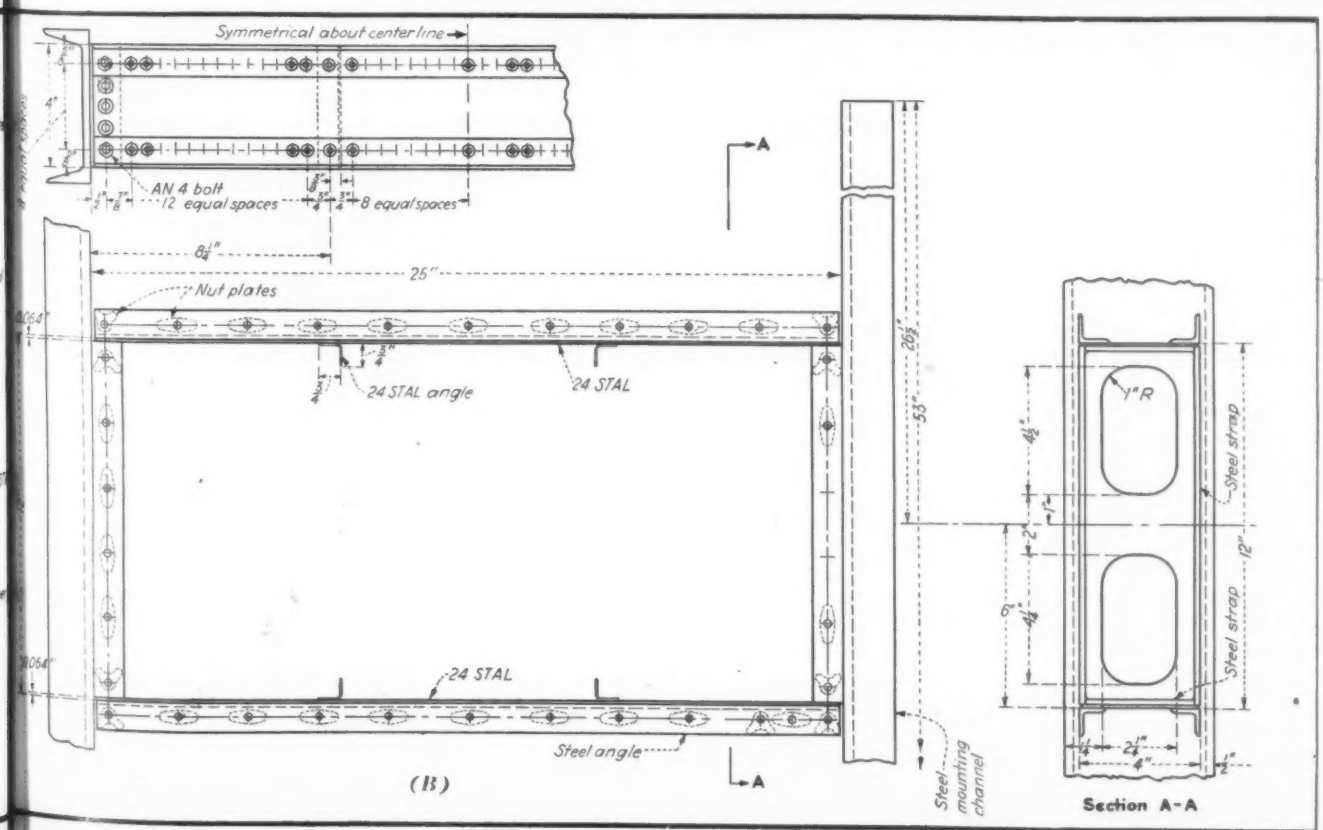
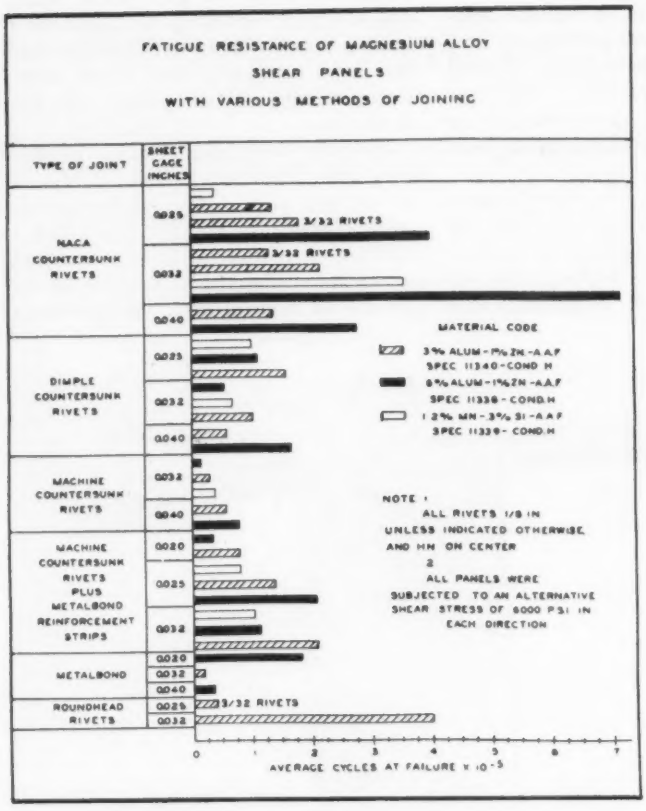
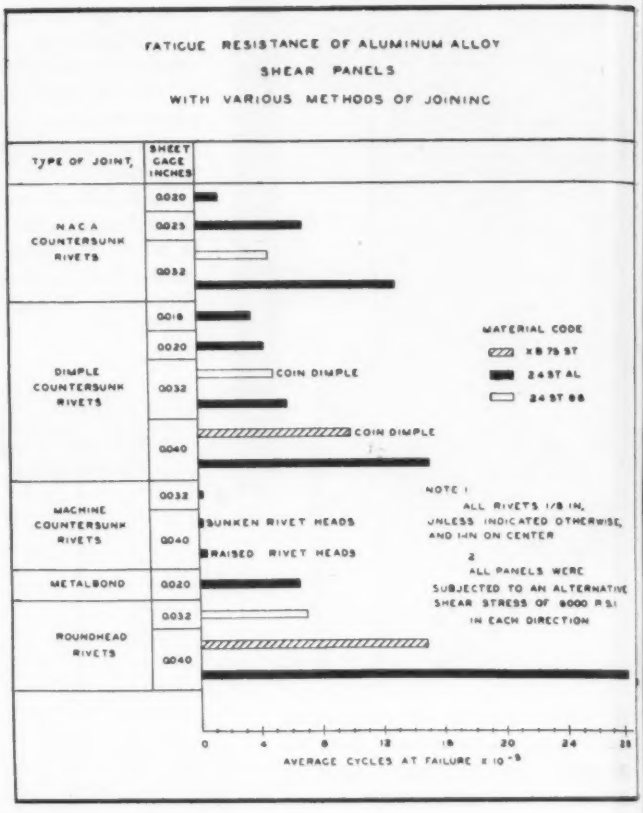


Fig. 3—Test apparatus indicating method of construction, suspension and location of test piece, vibrator and weight slugs.




FATIGUE RESISTANCE OF MAGNESIUM ALLOY
SHEAR PANELS
WITH VARIOUS METHODS OF JOINING
TYPE OF JOINT
SHEET GAGE INCHES
NACA COUNTERSUNK RIVETS
DIMPLE COUNTERSUNK RIVETS
MACHINE COUNTERSUNK RIVETS
MACHINE COUNTERSUNK RIVETS PLUS METALBOND REINFORCEMENT STRIPS
METALBOND
ROUNDHEAD RIVETS
3/32 RIVETS
MATERIAL CODE
3% ALUM-1% ZN-A.A.F SPEC 11340-COND H
6% ALUM-1% ZN-A.A.F SPEC 11338-COND H
1.2% MN-2% SI-A.A.F SPEC 11339-COND H
NOTE 1
ALL RIVETS 1/8 IN UNLESS INDICATED OTHERWISE AND 1IN ON CENTER
2
ALL PANELS WERE SUBJECTED TO AN ALTERNATIVE SHEAR STRESS OF 6000 P.S.I IN EACH DIRECTION
AVERAGE CYCLES AT FAILURE X 10-5



were bolted to the ends of the channels for balancing the test apparatus about the axis of the test piece.

The vibrator, driven by a variable-speed electric motor through a flexible shaft drive, consists of double counter-rotating masses so phased as to produce periodic translational impulses. This unit has the basic property of producing a force output proportional to the square of its driven speed or frequency. As the natural resonance of the mass is influenced by the material and rigidity of the individual test pieces, exact loading of each panel was obtained by controlling the vibrator speed or frequency on the upslope of the natural resonance curve of the test piece.

Electric strain gages were bonded at 45 deg. angles to the shear resistance webs of the torque box, and strains were observed on a Brush recording oscillograph. This method assured constant loading on the shear panels throughout the test, and at all times indicated a uniform harmonic motion.

As might be expected, the test results indicate a superiority for the round head rivets. For the flush type of riveting in magnesium alloy sheet, the N.A.C.A. rivets were superior. When reinforcements strips were bonded to the area at the rivet lines, the fatigue life of machine countersunk rivets was increased and the reinforcement strips were found to stay tight until failure occurred.

Observation of the test panels, while being fatigued, showed movement between sheet and rivets, at the start of the test, when machine countersunk rivets were used. As the test progressed, a rapid increase in deflection was observed, and as this became acute, impact loadings of some magnitude doubtlessly were applied to the joints. This condition was assumed to be the cause of premature rivet failures, and is characteristic of machine countersunk riveted joints in thin sheets.

Since shop personnel tend to overcountersink, it was decided to check panels having raised or sunken rivet-heads. Two identical shear panels were fabricated with machine countersunk rivets; one panel having the rivet heads raised 0.002 to 0.006 in. above the sheet, the other having the rivet heads 0.002 to 0.006 in. below the surface of the sheet. Failure of both shear panels occurred in the rivets but the panel, fabricated with the raised rivet heads, had four times the shear fatigue life of the panel with the sunken rivets.

Fabrication of the test panels was controlled with considerable care, but certain inconsistencies occurred and some panel sheets were noticeably loose and exhibited an oil-can effect. All panels having loose sheets exhibited a decided decrease in fatigue life when compared to similar panels with tight sheets. This lower fatigue life was probably caused by the combination of bending stresses with pure shear loading.

Care was taken to discontinue all tests only after a decided and comparable failure was observed. In some instances a small crack, believed to have resulted from a local stress concentration, was observed early in the test of an individual panel. This was not considered to be a failure until the comparable condition of failure was attained.

Without an exception, when sheet failures in riveted specimens occurred, cracks emanated either from the rivet holes or, in the case of dimpled sheets,

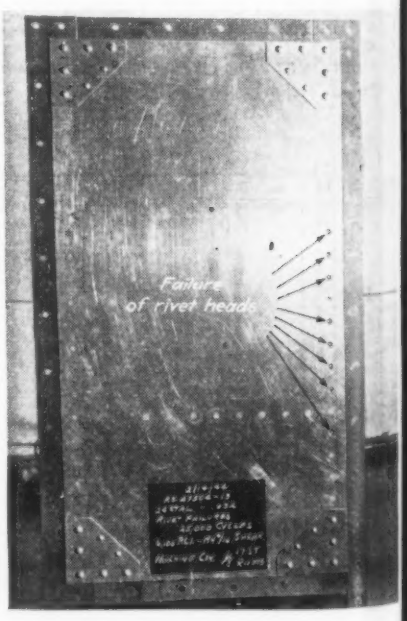


Fig. 4—Characteristic shear panel failure of machine countersunk rivets.

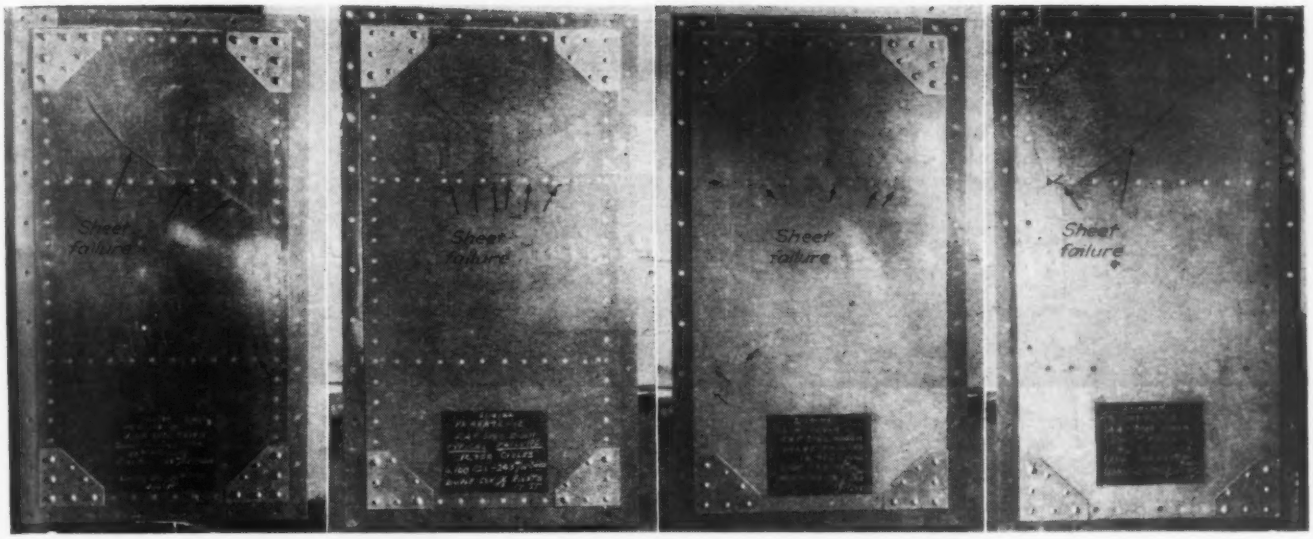


Fig. 5—Fatigue failure of magnesium alloy sheets indicating the rather complete failure resulting from cracks starting at the rivets. This brittle characteristic is most pronounced in high strength sheets.

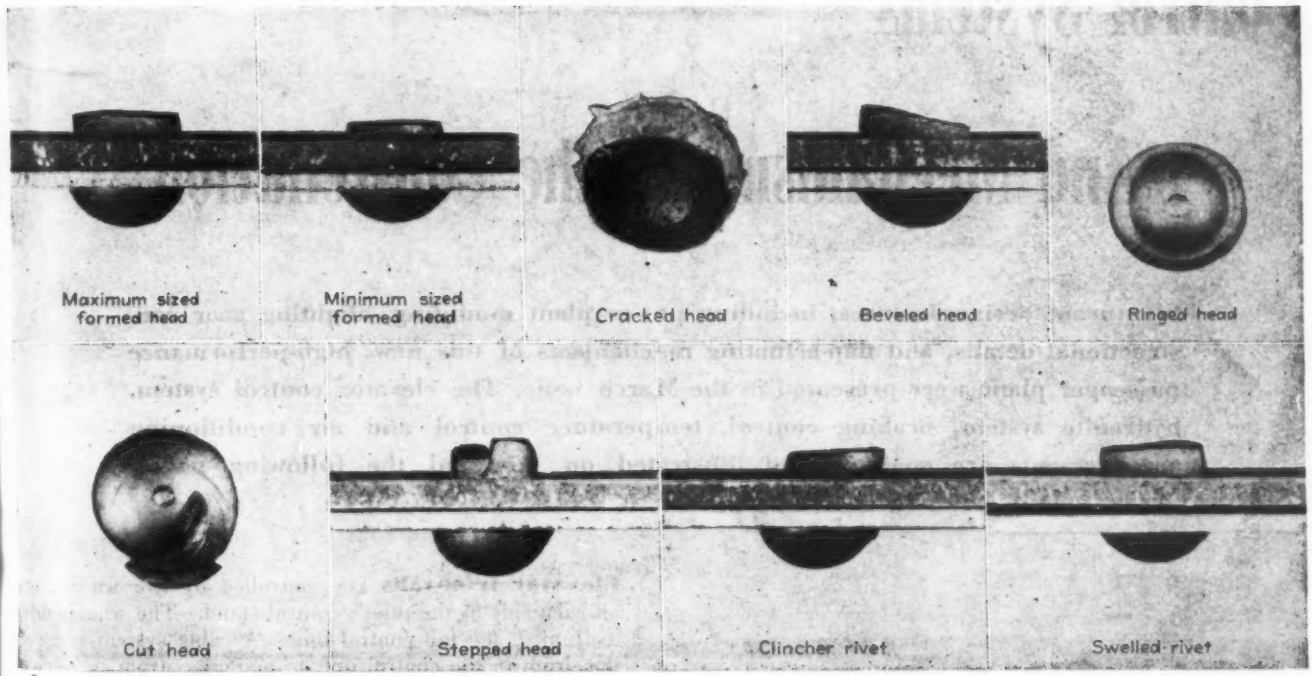


Fig. 6—Types of improperly driven rivets used in test panel to determine their effect upon fatigue failure.

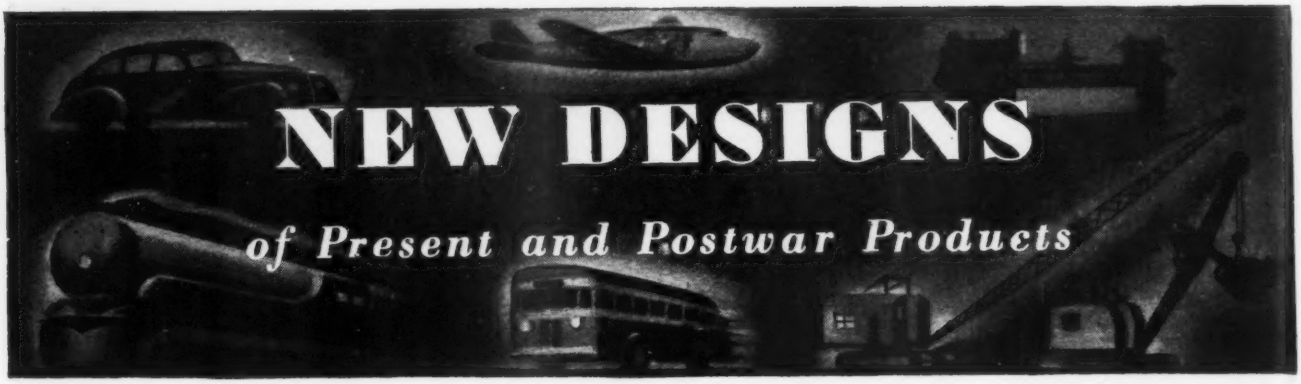
from the periphery of the dimples. Certain magnesium alloys, upon first formation of a sheet crack, rapidly produced extensive fissures.

Improperly driven rivets were tested by fabricating two identical test specimens in which the panels were riveted to the torque box and three improperly driven rivets were located between groups of two good rivets. Improperly driven rivets were of seven different types.

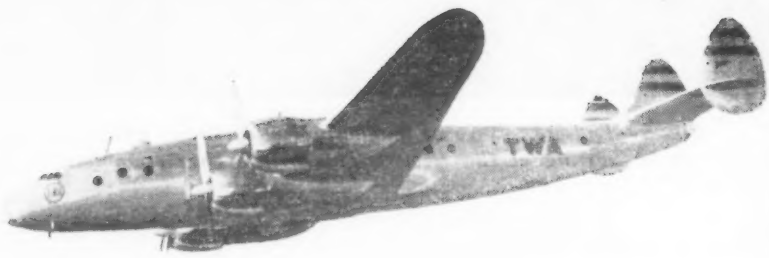
In one test specimen all improperly driven rivets were drilled out and replaced with good rivets. The two specimens were then tested under identical conditions, and when rivets failed they were replaced and the test continued until a sheet failure occurred. Results indicated that the specimen containing improperly driven rivets was superior in fatigue to the specimen in which improperly driven rivets had been replaced. Rivets of the swelled type were found to have the least desirable fatigue characteristics.

Maximum fatigue life can be obtained in fabricated structures when care is taken in the selection of material and type of rivet. Careful control of fabrication is also important as loose panels, exhibiting an oil-can effect, have lower fatigue life than tight panels of identical designs. Improperly driven rivets do not affect fatigue life when compared to improperly driven rivets that have been replaced with correctly driven rivets.

When comparing equal gages of material, it was found that the aluminum alloy sheets are generally superior in fatigue to the magnesium alloy sheets. The designer must therefore consider this item when attempting to save weight by using a lower density material in locations subject to vibration. The high strength magnesium alloy sheets exhibit a somewhat brittle fracture rather than a progressive one, especially when flush type riveting is used. Round head rivets gave the maximum fatigue life, while the N.A.C.A. countersunk type appears to be superior when flush type riveting is necessary.

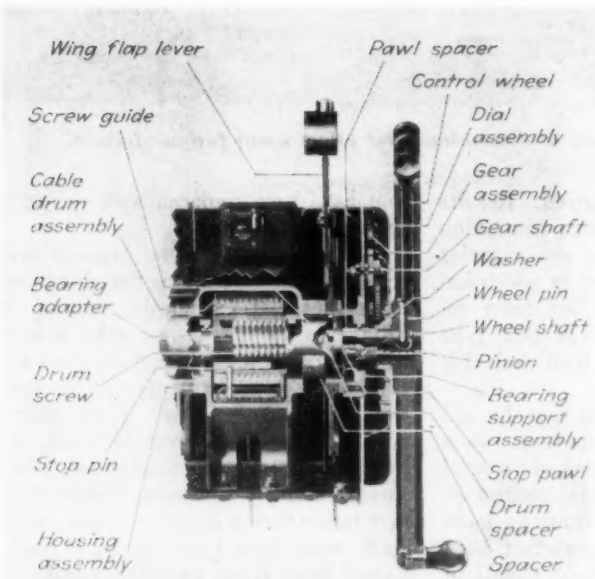


Control Systems



And Mechanisms in the Constellation

Significant design features, including power plant mounting, alighting gear constructional details, and flap-actuating mechanisms of this new, high-performance passenger plane were presented in the March issue. The elevator control system, hydraulic system, braking control, temperature control and air conditioning arrangements are analyzed and illustrated on this and the following pages.

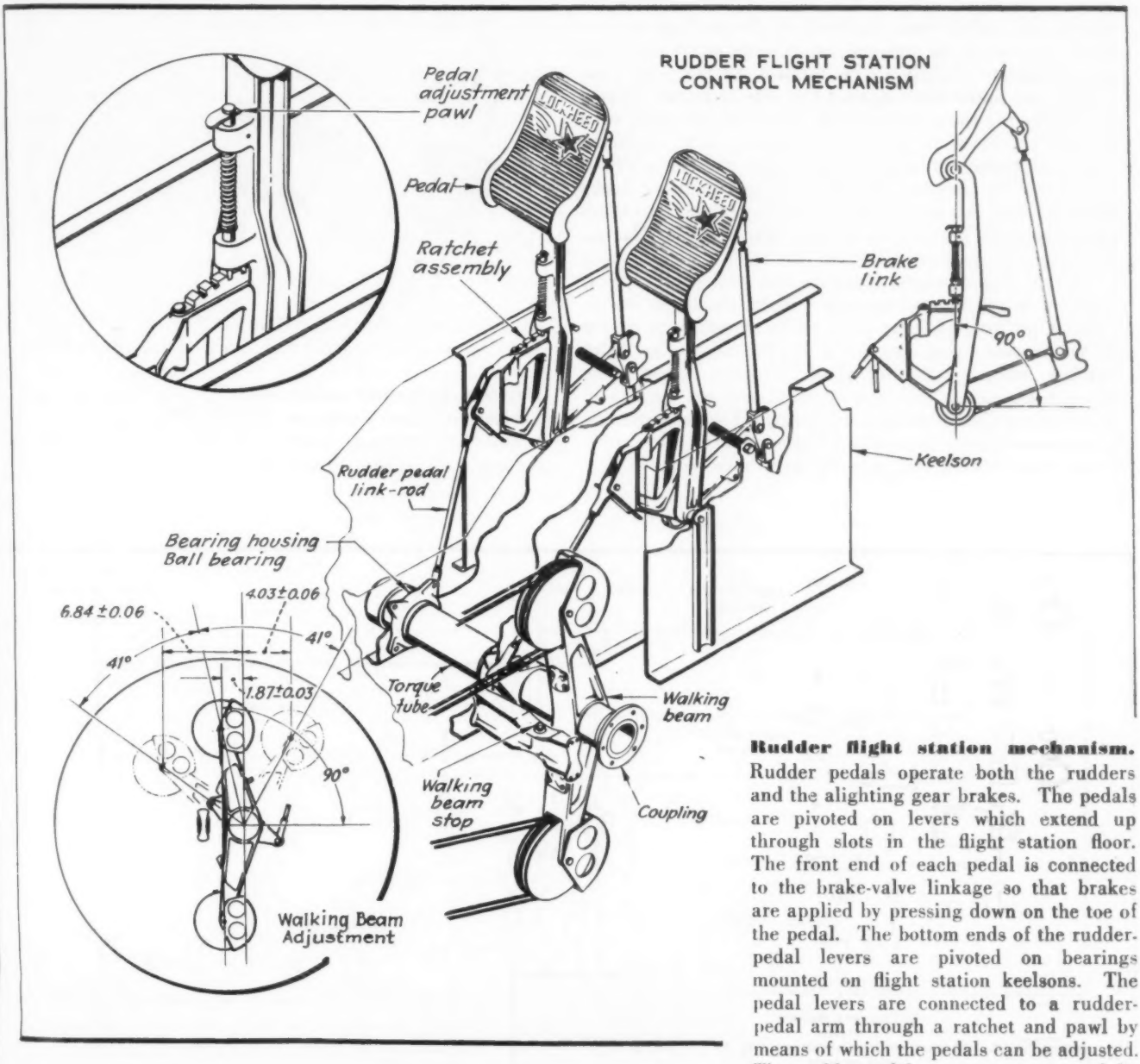


ELEVATOR TAB CONTROL MECHANISM

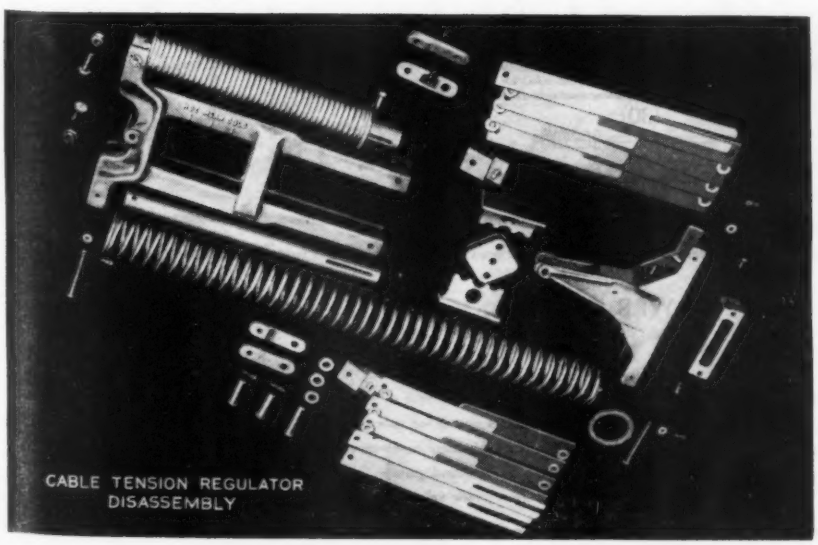
Elevator trim-tabs are controlled by two wheels, one on each side of the pilot's control stand. The wheels drive a drum in the tab control unit. A cable system connects the drum in the control unit to a similar drum in each of the tab operating units, which are located in the stabilizer. The cable-operated drum in each operating unit drives two actuating-screws which connect to the tab-actuating linkage. The actuating linkage is arranged so that elevator motion causes the tab deflection to change, reducing the control force necessary to move the elevator especially with the boosters turned off.

The elevator tab-control mechanism is located in the pilot's control stand. Control wheels on the right and left side of the pilot's stand are directly connected to a cable drum in the stand by a hexagonal shaft which is also common to the engine control quadrant levers. A dial driven by the drum shaft through gears, indicates relative position of tabs. Three turns of the tab control wheel give full tab deflection in each direction.

When the drum is rotated in either direction, the internal thread moves the drum screw in or out of the drum. The screw guides prevent the drum screw from rotating. There are stop-lugs on both ends of the drum screw which engage the stop pin in the drum on the "down" tab and the stop pawl on the "up" tab.

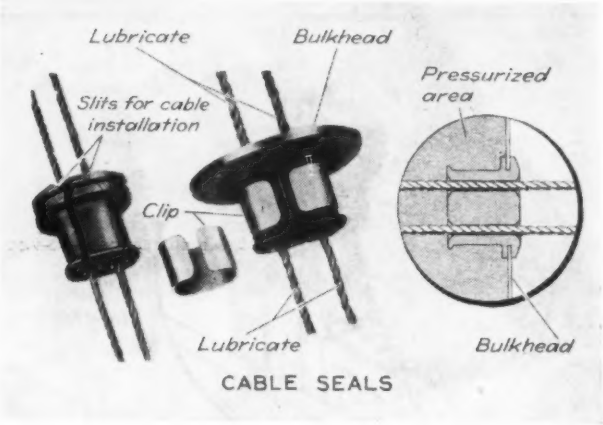


Rudder flight station mechanism. Rudder pedals operate both the rudders and the alighting gear brakes. The pedals are pivoted on levers which extend up through slots in the flight station floor. The front end of each pedal is connected to the brake-valve linkage so that brakes are applied by pressing down on the toe of the pedal. The bottom ends of the rudder-pedal levers are pivoted on bearings mounted on flight station keelsons. The pedal levers are connected to a rudder-pedal arm through a ratchet and pawl by means of which the pedals can be adjusted. The rudder-pedal arms are connected by links to a flight-station torque-tube which connects the pilot's and co-pilot's rudder controls. A walking beam on the torque-tube has a pulley at each end around which the rudder control cables pass. Adjustable stops limit the walking-beam travel to 41 deg. in each direction.

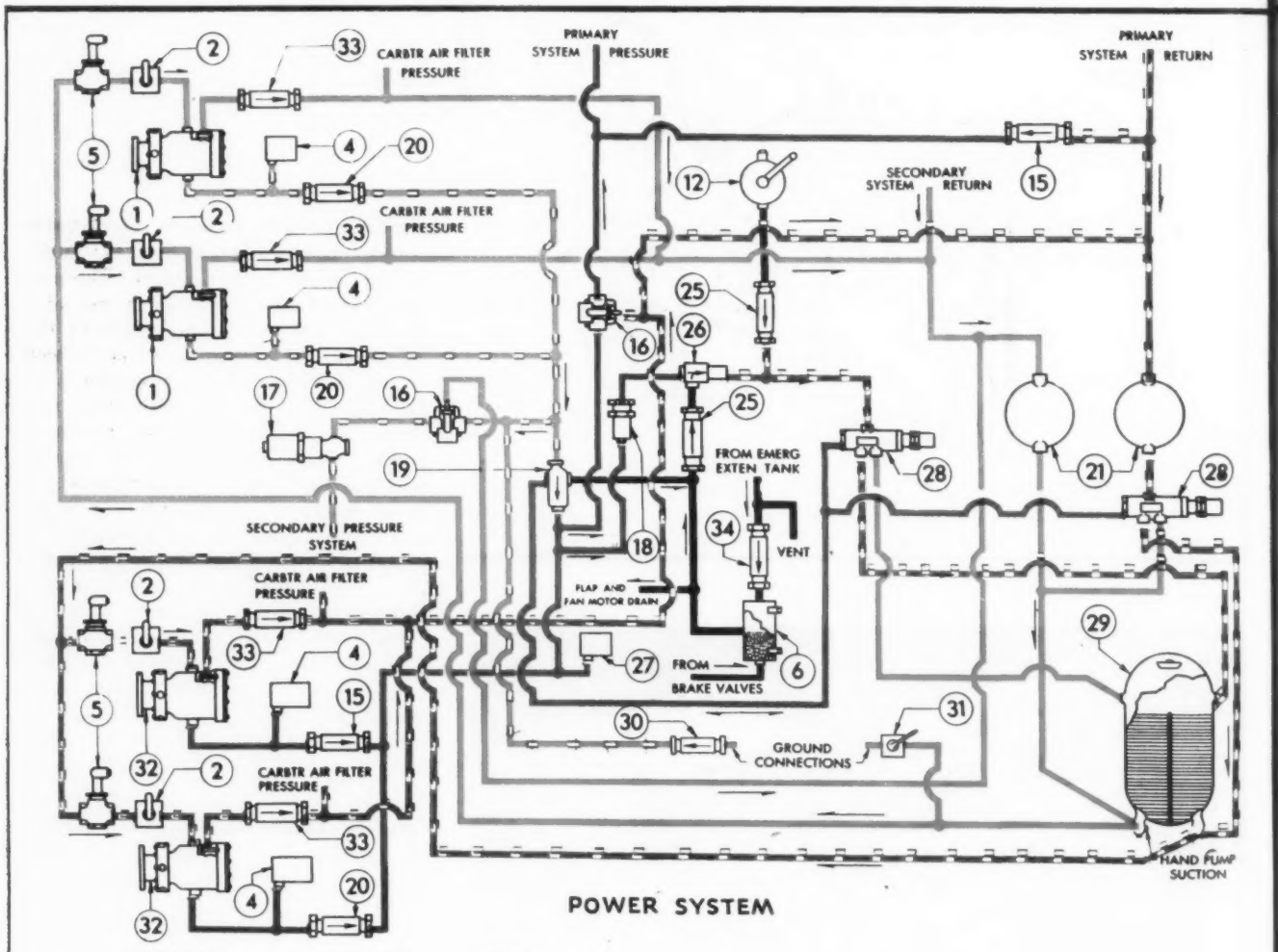

CABLE TENSION REGULATOR DISASSEMBLY

Cable tension regulators installed in the aileron,- elevator, and rudder control system, maintain approximately constant cable tension regardless of temperature changes. The "control-surface" ends of the cables are attached to a wrist-plate which pivots on a yoke. The yoke is spring-loaded to the frame of the tension regulator by two compression springs. These springs determine the cable tension as long as the control surfaces are not being moved and the cable loads in the

system are equal. When the flight station controls are moved to a point where air-loads on the surfaces are no longer balanced, the unequal cable loads produced rotate the wrist-plate slightly. The rotation of the wrist-plate pushes two brake shoes against two sets of leaves, located at each side of the regulator unit. Alternate leaves in each set are connected to the movable yoke. The remaining leaves are connected to the frame of the regulator which is attached to the airplane structure. The pressure of brake shoes on the leaves, caused by the wrist-plate rotation, prevents motion between the movable and stationary leaves. Therefore, the ends of the cables are held stationary with respect to the airplane structure and the cable system operates in the normal manner. When the flight station controls are released, the cable loads on each side of the system become equal, and the wrist-plate returns to center position, releasing the force on the brake shoes. The movable leaves are then free to move and the springs in the regulator determine the cable tension. The regulator can be disassembled for inspection when necessary to determine if corrosion, scoring and excessive wear have occurred.



Rubber-grommet cable-seals prevent loss of cabin pressure wherever cables are routed through pressure bulkheads. The cables are lubricated where they pass through the seals. Seals are assembled with clips.



POWER SYSTEM

COLOR CODE

- Primary system pressure
- Primary system return
- Secondary system pressure
- Secondary system return
- Sump tank (cabin) pressure

REF.	PART	REF.	PART	REF.	PART
1	Secondary system pump	6	Sump tank	11	Check valves
2	Suction shut-off valve (manual)	7	Autopilot restrictor valve	12	Emergency filler pump
3	Solenoid three-way valve	8	Hand pump suction selector valve	13	Alighting gear selector valve
4	Pressure warning switch	9	Emergency hand pump	14	Tail bumper compensator
5	Suction shut-off valve (solenoid)	10	Brake selector valve	15	Check valve

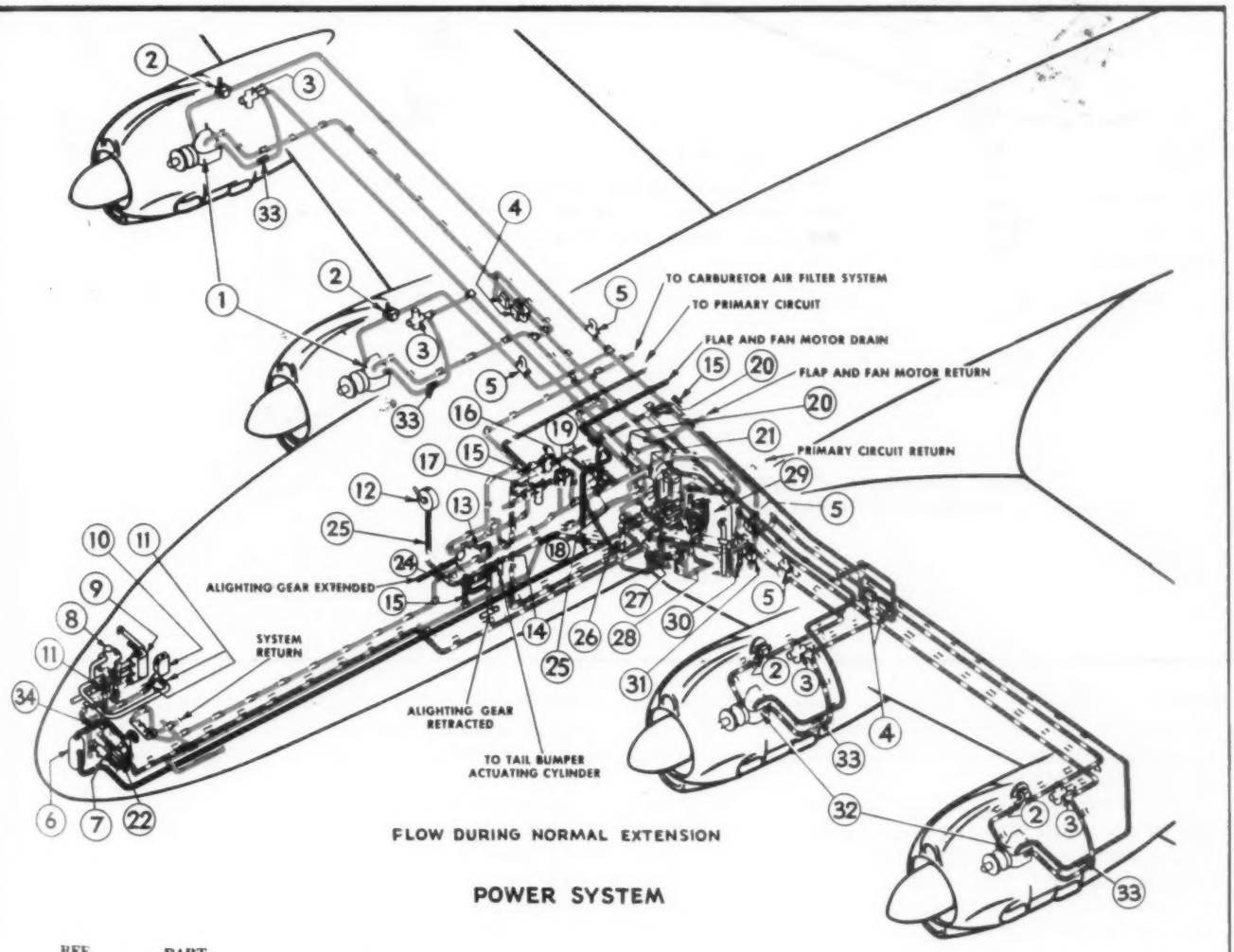
Hydraulic power is generated by four engine-driven piston-type variable-displacement pumps which circulate fluid at pressures up to 1,700 lb. per sq. in. Auxiliary power is supplied to the elevator and rudder surface-control booster by an electric motor-driven pump, and a hand pump provides emergency power to extend the alighting gear.

The engine-driven pumps are mounted one on each engine-accessory-drive housing. The two left-hand engines drive the "primary" pumps and the two right-hand engines drive the "secondary" pumps. Fluid is supplied to the pumps from separate compartments within the same reservoir. Whenever the primary pumps fail to generate pressure within 200 lb. per sq. in. of that delivered by the secondary pumps, the delivery from the secondary pumps to the secondary circuit is restricted and a portion or all of the secondary-pump capacity is directed into the primary circuit through a crossover check valve. A pressure-warning-light switch closes at 1,325±50 lb. per sq. in. pressure and opens at 1,450±50 lb. per sq. in. is installed in each pressure line.

Hydraulic fluid is stored in a two-compartment reservoir located near the leading edge of the left-hand wing center section. Primary fluid is withdrawn from and returned to one compartment and secondary fluid is withdrawn from and returned to the other copartment. When the crossover check valve is open, all fluid is returned to the secondary fluid compartment.

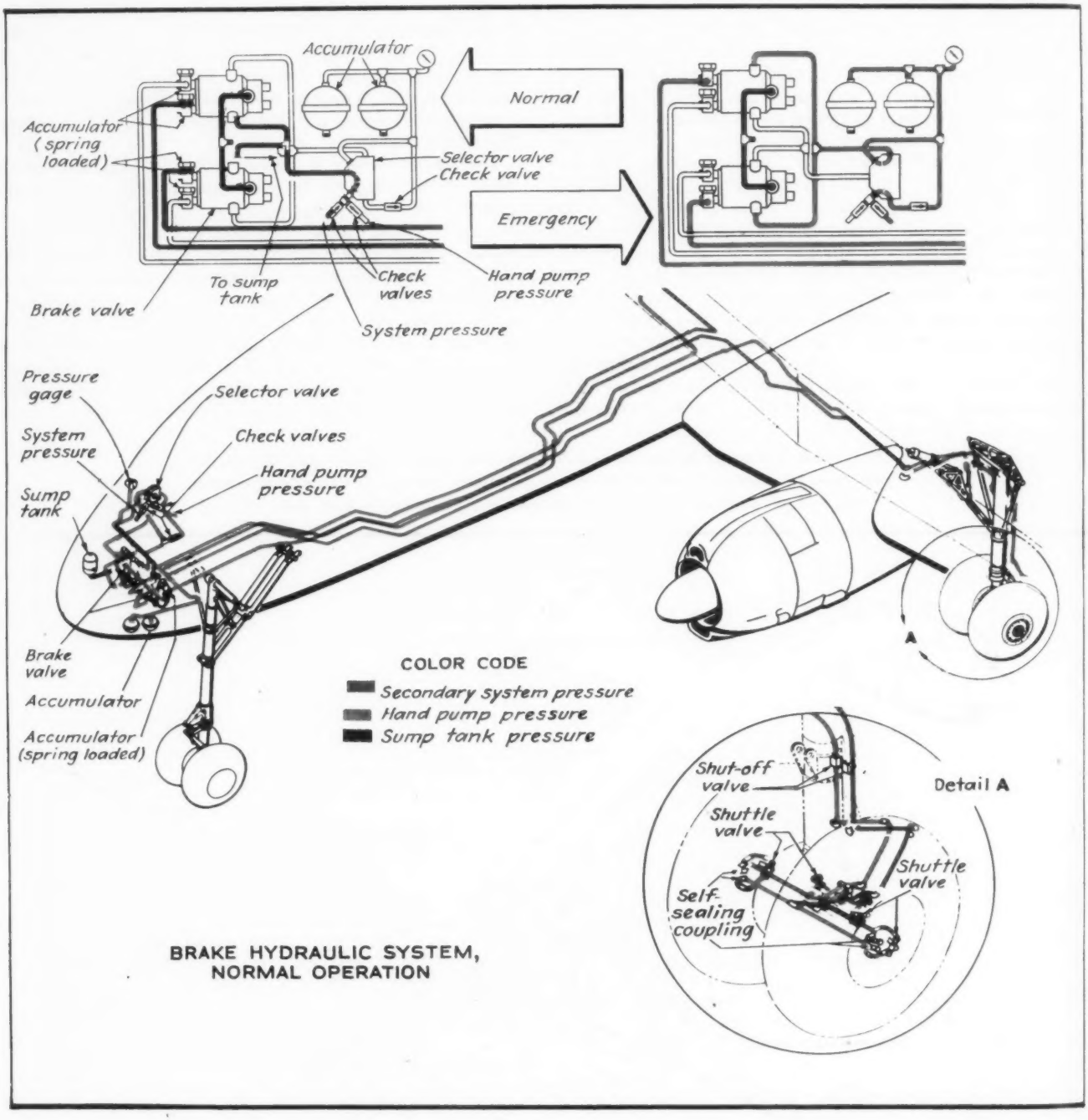
The main reservoir is pressurized by an aspirator which receives fluid pressure from a connection to the primary-circuit pressure line. The aspirator, by jet action, draws air and fluid from a return sump tank and discharges into the main reservoir. The addition of air increases the pressure within the main reservoir. A relief valve located in the reservoir filler cap limits the pressure in the reservoir to approximately 25 lb. per sq. in. Fluid can be added to the main reservoir if necessary during flight, from an auxiliary fluid container, by means of a wobble pump and flexible hose. Paper-type filters are provided in the system to remove dirt and fine particles of metal. (*continued on next page*)

Schematic layout of hydraulic power system is shown at lower left. Location of units in relative positions on plane is shown below. Pressure and return lines, and primary and secondary systems are distinguished by color-coding.



POWER SYSTEM

REF.	PART						
16	System relief valve	21	Main filter	26	Aspirator		
17	Restriction control valve	22	Autopilot pressure reducing valve	27	System pressure transmitter	31	Ground test suction valve
18	Aspirator filter	23	Steer caster valve	28	Return change-over valve	32	Primary system pump
19	Cross-over check valve	24	Tail bumper shut-off valve	29	Main reservoir	33	Check valve
20	Check-valve	25	Check valve	30	Ground test pressure check valve	34	Check valve



BRAKE HYDRAULIC SYSTEM, NORMAL OPERATION

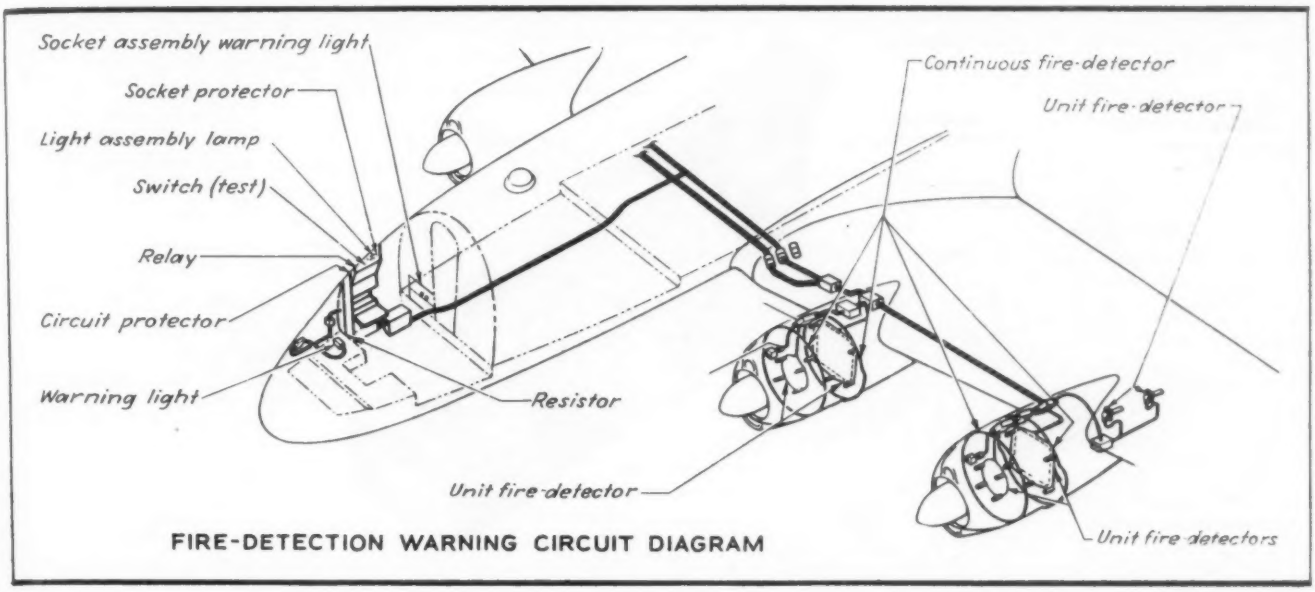
Brakes attached to the main-gear wheels are normally pressurized by the secondary pumping system. However, there is an emergency system which is supplied by five-inch hydraulic accumulators.

Depressing the toes of the rudder pedals operates dual brake valves which direct hydraulic pressure fluid through small accumulators to shuttle valves and to the brakes. Either the normal or the emergency brake valves and lines are used, depending upon the setting of a selector valve located in the pilot's control stand. The small spring-loaded accumulators absorb fluid displaced by the action of the unused control valves, and prevent locking of the brake pedals. The shuttle valves prevent fluid from passing back through the inactive line.

The two 5 in. accumulators provide fluid pressure for parking or emergency braking. They are precharged with 600 lb. per sq. in. air pressure and are hydraulically charged with secondary pressure or emergency hand-pump pressure when the selector valve is in the emergency position. A gage in the accumulator lines indicates the accumulator pressure.

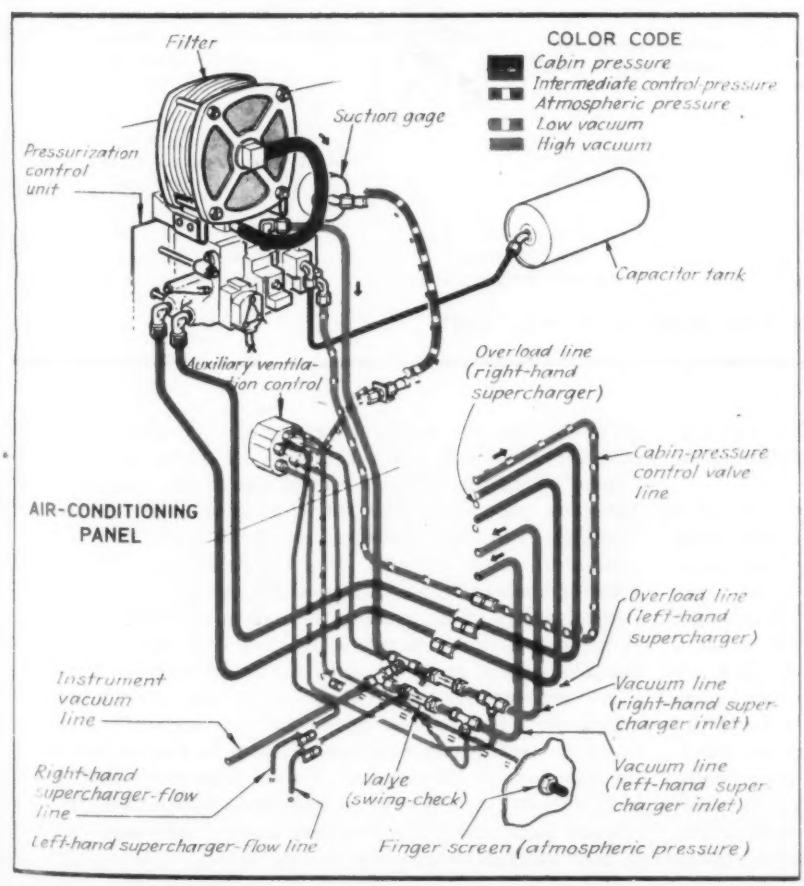
The brake selector valve has three cam-actuated, spring-loaded poppet valves. In the normal brake position the brake valves are connected to system pressure and to hand-pump pressure. In the emergency-brake position the system and hand-pump pressures are connected to the accumulators and to the brake valves.

The brake control valve has two identical valve assemblies within a single body. One valve regulates normal pressure and the other valve regulates emergency pressure. A valve sleeve, centered between two springs, controls the amount of pressure fluid entering the brake lines and relieves pressure to the return line as required to maintain a force on the brake which is proportional to that applied to the pedals.



FIRE-DETECTION WARNING CIRCUIT DIAGRAM

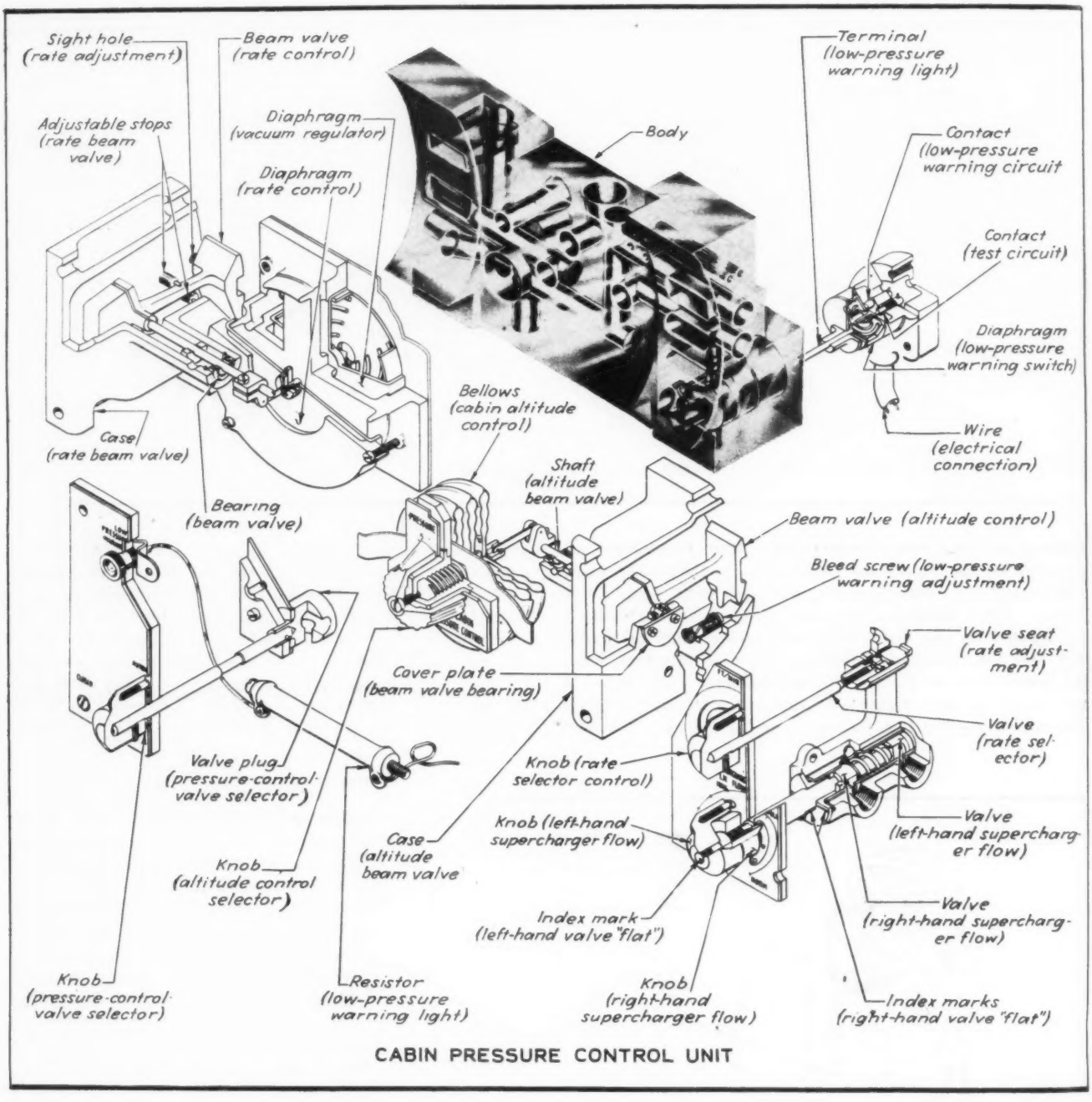
Unit-type and continuous-type fire detectors are provided in the nacelles to detect fires in the power plant. Additional unit detectors are provided near each cabin heater. Eight warning lights, for power-plant fire warning, are located on the flight engineer's upper electrical panel. The four top lights are lighted by the unit detectors, while the lower four are lighted by the continuous detectors. A test switch for these lights is located to the left of the lights. The circuit breaker is adjacent to the light bank. A master fire-warning-light, located on the front windshield frame, is actuated by a relay whenever any fire detector is actuated. Two warning lights, located on the air conditioning panel in the cabin, are provided for cabin-heater-duct fire detection. The unit-type fire detector completes the circuit to ground when the temperature of the sensitive element is greater than 177 deg. C. (350 deg. F.). It resets automatically upon cooling below this temperature. Detectors are mounted on the aft face of fire seal to detect fire occurring in the power plant.



Cabin pressure-control unit. When the control unit is set for "automatic" operation, two beam valves in the unit control the cabin pressure-control valves. The cabin-altitude beam valve maintains the cabin pressure (altitude) at any desired preset valve, and the rate-control beam valve limits the rate of change of cabin pressure to any desired present maximum.

The cabin altitude control consists of a knob and a graduated dial for setting the desired cabin pressure (altitude). Rotation of the knob actuates a jackscrew attached to one side of a sealed bellows which is sensitive to pressure (altitude) changes. The other side of the bellows is attached to the linkage which moves the balanced beam valve. This beam valve controls the vacuum that is applied to the pressure control valves in response to pressure changes on the bellows.

For example, a decrease in cabin pressure (increase in altitude) permits the bellows to expand, thus causing the valve to move down restricting the port to the pressure-control valve. This reduces the vacuum applied to the "opening" side of the pressure-control valve control-piston and causes the pressure-control valve to close. If the decrease in cabin pressure is great enough to cause the altitude beam valve to move all the way down, the beam



CABIN PRESSURE CONTROL UNIT

valve closes the vacuum port to the low-pressure warning-light switch. The pressure switch then closes, turning on the warning light.

The cabin rate (pressure change) control consists of a diaphragm linked to the balanced beam valve. This beam valve throttles the vacuum being applied to the cabin-pressure-control-valve control-piston during changes in cabin pressure (altitude). One side of the rate control diaphragm is open to cabin pressure while the other side is open to cabin pressure through an adjustable rate-control bleed valve. A capacitor tank provides the proper volume to the bleed-valve side of the diaphragm. Pressure on the cabin side of the diaphragm changes more quickly than pressure on the bleed-valve side of the diaphragm. This difference in pressure causes the diaphragm to deflect, thus moving the rate-control beam valve across the port to pressure-control valves.

The pressure-control valve selector knob actuates a plug valve set into the passage between the altitude beam valve and the rate-beam valve chamber. Turning this knob to "open" shuts the altitude control out of the circuit and at the same time opens the rate-control chamber to pressure regulator vacuum. In this manner control over rate-of-change of cabin pressure is still maintained. Turning the selector knob to "close" shuts off all vacuum to the pressure control valves, thus causing the valves to close. However, if pressure within the cabin increases too rapidly, the rate beam-valve will move up until the lower edge of the beam valve uncovers the port connecting to the vacuum-pressure regulator. This action opens the pressure-control valves until the rate of cabin pressure change is that called for by the rate-control bleed valve. Cabin altimeter, rate-of-climb indicator, cabin temperature indicator, differential pressure suction gage and cabin pressure control unit are centrally located at flight engineer's station.

Automatic and manual control of the heat delivered to the airplane interior is by an electrical system having cabin master-thermostat, anticipating thermostats, control motors, and switchs.

Cabin air is obtained from a scoop in the leading edge of each wing and ducted to the engine-driven cabin supercharger, to the internal-combustion heaters, to the aftercooler or its bypass duct, and thence to the cabin-air distribution system.

The temperature-control system maintains a desired cabin temperature by regulating the amount of heat delivered by the heaters and by controlling the cabin-air heat exchange at the supercharged-air after-cooler.

The cabin is supplied with heated air by two separate heating systems which are controlled initially by a single bi-metal thermostat contained within the cabin main-thermostat. The bi-metal thermostat controls the left-hand heating system directly, and exercises control over the right-hand heating system through a Micro-positioner, so that both systems supply an equal amount of heat. Each system employs one 40,000 b.t.u. per hour heater in the outboard nacelles.

Two sources of cabin heat are provided and are capable of control. The cabin supercharger, located in each outboard nacelle, raises the temperature of the air being compressed. This air, passing through the aftercooler, causes a heat exchange which cools the supercharger air entering the fuselage. A controllable bypass-valve permits varying amounts of air to be shunted around the aftercooler, thus governing the heat exchange. When the bypass valve is fully opened, all of the air is bypassed around the aftercooler, and the heat generated is delivered to the cabin.

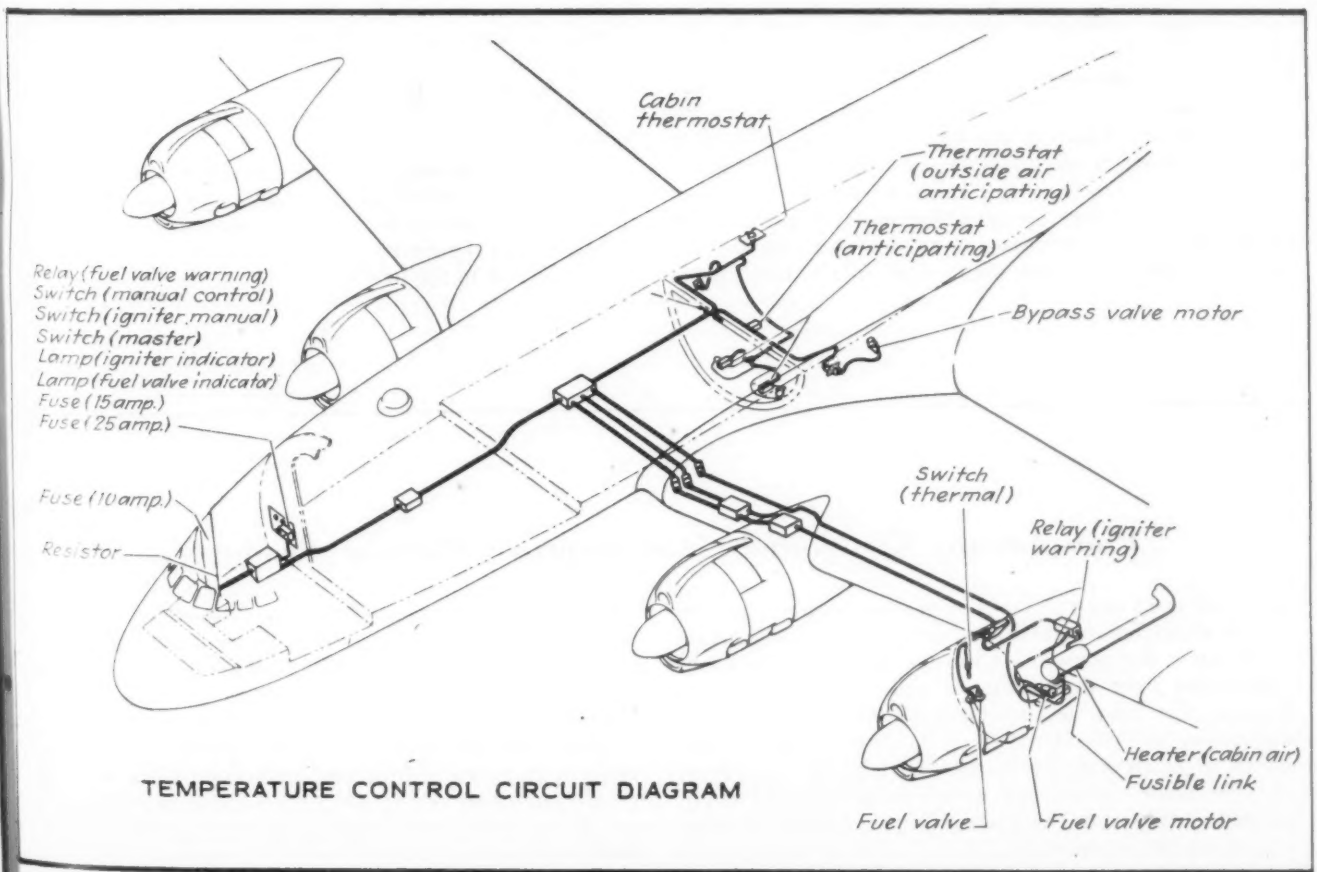
The bypass valve is actuated by an electric motor which is controlled by the cabin thermostat. When the heat requirement is such that the supercharger-heated air does not provide sufficient heating, the heaters in each outboard nacelle are automatically operated to provide the additional heat.

The controls for operating the cabin temperature-control system are located on the air-conditioning panel, immediately aft of the flight engineer's station. A single master-switch on the panel controls both the temperature-control circuit and the heater circuits. Two two-position switches, adjacent to the master-switch, control the heater igniters for manual starting of the heaters. These switches are spring-loaded in the "automatic" position and are momentary-contact in the "manual" position. Switches for the cabin temperature control system permit both automatic and manual control over the system. These switches are four-position switches with "automatic," "heat," "cool," and "off" positions. For automatic operation, all switches are in the "automatic" position, and the master-switch is "on."

The cabin-thermostat bi-metal contacts control the left-hand control motors directly. The motors connect through limit switches, sequence switches, and rheostats. The sequence switches are wired so that the bypass-valve motor is operated first to open the bypass valve, whereupon the sequence switch in that motor completes the circuit to the heater throttle-valve motor. A sequence switch in the throttle-valve motor does not permit closing of the bypass-valve until the throttle valve is closed.

An additional sequence switch, contained within the throttle-valve motor, controls the entire heater and heater accessory circuits. These circuits are operative when the throttle valve is opened approximately five degrees.

The right-hand heating system follows the left-hand heating system by the use of the Micropositioner, mounted within the cabin thermostat cover, and the rheostats contained



TEMPERATURE CONTROL CIRCUIT DIAGRAM

within the control motors. The Micro-positioner coil and the control motor rheostats form a part of a Wheatstone bridge. The series resistance of the two left-hand control motor rheostats form one arm of the bridge; and the two righthand rheostats form another arm. The cabin rheostat proportioning coil in series with the left-hand rheostats, forms the third arm. The fourth arm in series with the right-hand rheostats consists of a fixed resistor mounted on the outside of the cabin thermostat case. The coil of the Micropositioner is connected across the Wheatstone bridge at a point between the variable rheostats and the fixed resistors. Thus a change in the position of either control motor of the left-hand system causes a potential difference across the Micropositioner coil, which unbalances the system, closing appropriate contacts in the Micropositioner. This results in the operation of the right-hand motors to restore the balance of the Wheatstone bridge.

With the cabin temperature control system operating automatically and the system in the full cooling position, a need for cabin heat causes the bi-metal thermostat contacts to operate the left-hand bypass-valve motor. The bypass valve gradually opens, bypassing part of the warm supercharger air around the aftercooler. Operation of the bypass motor upsets the balance of the Wheatstone bridge and the Micropositioner contacts complete the circuit to the right-hand bypass motor.

The bypass valve continues to close gradually, according to the heat demand. When these valves are completely closed, the sequence switch closes the circuit to the heater throttle-valve motor. When the motor drive-shaft has rotated approximately five degrees, a sequence switch controlling the heater circuit closes, completing the circuit to the heater igniter, staring combustion of the fuel-air mixture. The throttle-valve is controlled to any opening by the cabin thermostat.

The proportional coil forming one arm of the Wheatstone bridge is used as a follow-up to prevent hunting of the control motors. Without the proportional controls, the motors would run beyond the correct position before the change in heat delivered could affect the cabin thermostat.

The proportioning coil exerts a magnetic force on the bi-metal coil, the change in this force being in a direction to oppose the force brought about by a temperature change.

Anticipating thermostats are employed to anticipate temperature changes before the cabin thermostat is aware of the change. During an increase in ambient temperature the anticipating thermostats operate to apply a false heat indication to the cabin thermostat, thus calling for cooling before the cabin temperature has actually increased.

The circuit to the heater igniter is completed through a series relay. When voltage is applied to the igniter, the relay contacts close to light an indicator light on the air conditioning panel. When the igniter thermal-switch opens, the circuit to the relay opens and the light goes out. This indicates that combustion is taking place within the heater. The relay is located in the outboard nacelle aft-junction-box.

The solenoid shut-off fuel valve circuit is controlled by the sequence switch in the throttle valve motor and by three series overheat switches and a fusible link. Two of the overheat switches are located within the heater housing and the third is attached to the heater exhaust-line by a metal clamp. The fusible link is screwed into the heater throttle valve assembly. The purpose of these switches is to shut off the supply of fuel to the heaters whenever an overheat condition arises. A series relay in the circuit actuates an indicator light to indicate when the fuel valves are open. The relay is located in the air conditioning panel.

Two 40,000 b.t.u. per hour internal-combustion heaters provide heated air to the airplane interior. The heaters are located one in each outboard nacelle.

The electrical components of the heater include an igniter and thermal switch for heater automatic-starting, an igniter for heater manual-starting, two overheat switches, and a fusible link. Accessory equipment includes the control switches, relays, exhaust-duct over-heat switch, and two fuel valves.

The fuel-air mixture admitted to the heater is controlled by the two fuel shutoff valves and the setting of the throttle valve on the heater. The mixture is initially ignited by contact with the hot wire glow plug, or igniter. With the control switches in "automatic," the circuit to the igniter is broken by the igniter thermal switch when the fuel mixture has become ignited. The mixture maintains its own combustion when ignition is once started. For manual operation, ignition is started with a separate igniter plug which does not incorporate a thermal switch in its circuit. Upon ignition, the igniter is turned off by releasing the switch on the air conditioning panel.

Two overheat thermal-switches are wired in series with the exhaust thermal switch, the fusible link, and the two solenoid fuel-valves. When the heater becomes overheated, these switches open the circuit to the fuel valves, shutting off the supply of fuel to the heater.

Phosphorous Compounds May Improve Postwar Products

ONE OF THE MOST PROMISING of the various phosphorous compounds is aluminum metaphosphate from which can be manufactured glass that transmits a substantially greater amount of ultraviolet light than ordinary glass.

Because they show less tendency to yield a haze, phosphate glasses are considered likely to solve certain optical problems associate with astronomy, photography and related fields. Phosphate glasses show improved resistance to weathering and certain acids, improved color control and melting and working characteristics.

A companion metaphosphate has properties that suggest uses as a thermal insulator. It is a chemical oddity in that volume increases 500 times under high temperatures. Another type imparts superior characteristics to ceramics.

Tetra-lead pyrophosphate is a white paint pigment that is shown in light reflectance tests to be superior to conventional titanium pigment. Ferric orthophosphate gives flour and cereals more than twice their normal amounts of iron. Postwar, Montanto Chemical plans to produce phosphorous compounds in volume.

To Whom Should Go the Credit?

THE highly-prized American spirit of teamwork applied to the rapid development of machines and instruments for war has made it almost impossible to determine who should be credited for certain inventions. In instances when a specified group of men working in collaboration produce a new invention it is unjust to credit the accomplishment to one or two persons.

Companies that are mindful of being fair to their employees are always careful in announcing credit for a new development. If a group of men actively participated in a research program, each man in the group is credited. If a complicated machine requires the perfection of a number of devices, credit for the design is not given solely to the individual who invented one of the units.

During this war a number of regrettable claims to invention have been made by companies desiring to establish themselves in the public eye as being outstandingly progressive. By implication, if not direct claims, a number of companies invited credit as the inventor of radar, which was perfected by international teamwork. One small company that developed the design of one of the components of a gun director described itself as having invented and developed the whole equipment. Another company that developed the production model of a gun sight invented by a service man claimed that it was only its design that made the device practical and hence the credit for the development should go to them.

When a number of companies are working on a project it is utterly impossible to distribute credit with any degree of fairness. No machine is useful until every one of its elements has been perfected. To develop the gas turbine required new data on the behavior of gases at high pressures and temperatures; new alloys that would withstand temperatures higher than ever used in turbines had to be found; methods for working these alloys had to be developed. Numerous other problems in the fields of combustion, metallurgy and mechanical design had to be solved. A half-dozen or more companies participated.

In fairness to the many men and women who gave their best to the development of war materiel, let it be said that it was the team and not an individual player that achieved the goal. Proper honor and glory will come to the individual through the acclaim of his associates. The fact that the team worked under the banner of the XYZ company can usually be regarded as incidental.

G. F. Rodenhold

Relation Between Hardness And Other Mechanical Properties

T. H. GRAY
Research Engineer, Westinghouse Electric & Mfg. Company

Non-destructive hardness testing, employed in evaluating other mechanical properties, is discussed and formulas and graphs are given which will assist in the fuller utilization of this test. Practical examples illustrate its use in design and shop practice.

HARDNESS tests are now widely used to check not only hardness as such, but also to control heat-treatments, and to evaluate mechanical qualities on the basis of their relationship to hardness. Such tests are simple and quick to make and are non-destructive. However, the evaluation of properties in terms of hardness numbers is not merely a matter of substituting in a formula, but requires also a knowledge of other factors.

The relationships between the hardness of a metal and its other mechanical properties such as tensile strength, fatigue strength, wear resistance, machinability and ductility, are not precise, are different for different metals and are influenced by a number of factors. The formulas are all empirical, based on test results, and the constants are different even for the same material in its various forms such as forgings, castings or strip. Sometimes it is necessary to make supplementary physical tests to obtain an accurate result. Proper allowances must also be made for inherent deviations between the formula evaluation and the true value.

Hardness Versus Tensile Strength

Tensile strength is perhaps the physical property that is most commonly evaluated by conversion from hardness numbers. It is much easier to check and hence is preferable for many material specifications. Two investigators, T. H. Gray and H. Scott, have established an empirical formula for steel that has shown good results. This is presented in the paper "Hardness Conversion Relationships For Hardened Steels," *A. S. M. Transactions*, 1940. Messrs. Gray and Scott developed the following empirical equation in which DPH means the diamond pyramid hardness number.

Tensile Strength in lb. per sq. in.
= 494 x DHP − 7,000

This formula, with a possible error of 10 percent, can be applied in estimating tensile strength from hardness test values of wrought solid bar steel between 200 and 660 diamond pyramid hardness. These DPH valves are obtained on a Vickers hardness tester. Table I can be used conveniently for converting these readings to other scales of hardness numbers.

W. J. Taylor analyzed the same problem in his article "The Hardness Test as a Means of Estimating the Tensile Strength of Metals", *Journal of the Royal Aeronautical Society*, August 1942, and set forth his conclusions in the following series of formulas:

(1) For steel sheet, strip, and tubes, ranging from 200 to 660 DPH numbers
Tensile strength in lb. per sq. in.
= 0.185 to 0.24 x DPH x 2,000

(2) Wrought aluminum-rich alloy bar
Tensile Strength in lb. per sq. in.
= 0.21 to 0.27 x DPH x 2,000

(3) Wrought aluminum-rich alloy forgings
Tensile Strength in lb. per sq. in.
= 0.185 to 0.26 x DPH x 2,000

(4) Wrought aluminum-rich alloys, extruded sections
Tensile Strength in lb. per sq. in.
= 0.185 to 0.24 x DHP x 2,000

(5) Aluminum rich alloy sheets, strips and tubes of hardness less than 100 DPH,
Tensile Strength in lb. per sq. in.
= 0.21 to 0.26 DPH x 2,000; of hardness greater than 100 DPH,
Tensile Strength in lb. per sq. in.
= 0.21 to 0.24 x DPH x 2,000

(6) Wrought copper-rich alloys
Tensile Strength in lb. per sq. in.
= 0.18 to 0.24 x DPH x 2,000

The data on hardness and tensile strength for steels are graphically shown in Fig. 1, which was obtained from investigations on structural and tool steels.

Hardness versus Wear Resistance

The relationship between hardness and wear resistance is complicated by the effects of composition, heat-treatment and structure of the metal impurities, surface conditions, temperatures and other factors, so that empirical equations for calculating wear from hardness data would be of little value. Chrominum additions, for instance, raise the wear resistance of steels, and for equal hardness, steels with 5 to 15 percent Cr will have two to three times the wear resistance of the unalloyed steel.

The relationship between hardness and wear is even more anomalous when hard-facing metals of the Stellite type and hardened alloy steels are compared. Although hard-facing metals are relatively solft (25 to 30 Rockwell C on the average), compared with hardened alloy steel of 60 to 68 Rockwell C, their life is between two and ten times greater, because they contain hard carbides imbedded in a soft matrix. This lack of correlation between hardness and wear is also shown by a comparison of wear resistance presented by E. E. LeVan in "Wear of Metallic Surfaces", in *Metals & Alloys*, July 1937. In this report, heavy metal carbides are designated as Group I, hard non-ferrous alloys, such as Stellite, as Group II, hard

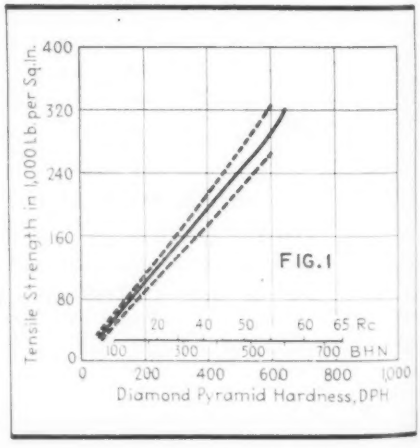


Fig. 1—Approximate relationship between hardness and tensile strength of steels.

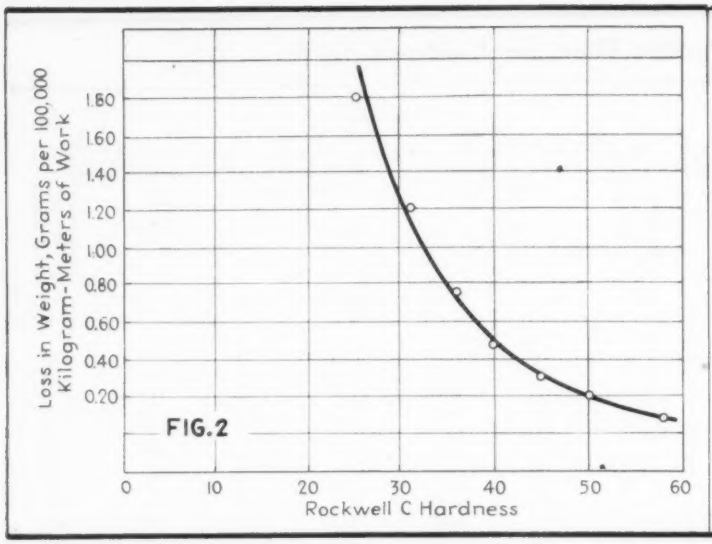
Table I—Hardness Conversion Chart for Hardened Steels

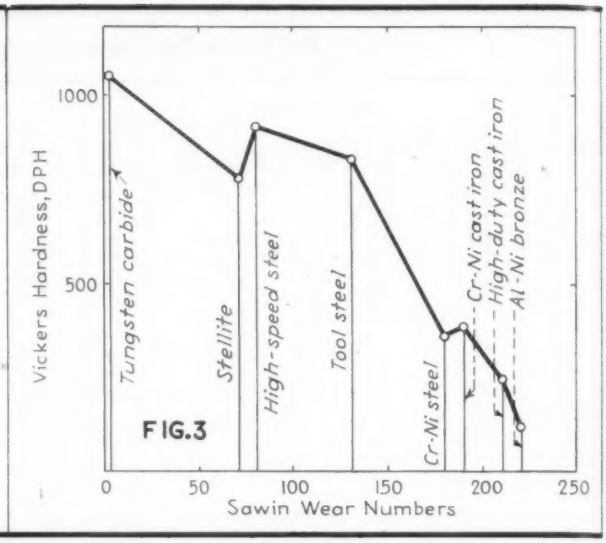
Vickers Pyramid Number 50-Kg. Load	Rockwell Hardness					Scleroscope Hardness	Monotron Load Scale Value (9 Divisions)	Brinell Hardness 10 mm. Ball, 3000-Kg. Load				Approximate Tensile Strength of Steel	Vickers Pyramid Number 50-Kg. Load
	C-Scale-150 kg. Brale Penetrator	A-Scale-60 kg. Brale Penetrator	Superficial (Wilson Chart No. 38)					Hultgran Ball VPN 970		Steel Ball VPN 930			
			15-N Scale	30-N Scale	45-N Scale			Hardness Number	Diameter in mm.	Hardness Number	Diameter in mm.		
VPN	RC	RA	15-N	30-N	45-N	Scl.	Mon.	BHN	mm.	BHN	mm.	T.S.x10³	VPN
210	16.7	57.6	67.3	39.3	16.0	33.5	26.6	200	4.27	200	4.27	102	210
220	18.4	58.7	68.3	40.7	17.8	35.2	28.1	209	4.18	209	4.18	106	220
230	20.1	59.8	69.3	42.1	19.6	36.7	29.6	218	4.10	218	4.10	109	230
240	21.7	60.7	70.3	43.5	21.3	37.9	31.0	228	4.01	228	4.01	113	240
250	23.3	61.6	71.2	44.8	23.4	39.1	32.3	237	3.92	237	3.92	118	250
260	24.8	62.5	72.1	46.1	25.1	40.3	33.7	247	3.85	247	3.85	123	260
270	26.2	63.2	72.9	47.3	26.8	41.5	35.0	256	3.78	256	3.78	127	270
280	27.6	63.9	73.6	48.4	28.4	42.8	36.3	266	3.72	266	3.72	131	280
290	28.8	64.6	74.3	49.5	30.0	44.0	37.6	275	3.66	275	3.66	136	290
300	30.0	65.3	75.0	50.6	31.4	45.2	38.9	285	3.59	285	3.59	140	300
310	31.2	65.9	75.7	51.7	32.8	46.4	40.1	294	3.53	294	3.53	145	310
320	32.4	66.5	76.4	52.8	34.2	47.6	41.3	304	3.48	304	3.48	150	320
330	33.6	67.1	77.0	53.7	35.6	48.8	42.5	313	3.44	313	3.44	154	330
340	34.7	67.7	77.6	54.7	36.9	49.9	43.7	323	3.39	323	3.39	158	340
350	35.8	68.2	78.2	55.6	38.2	50.9	44.8	332	3.35	332	3.35	162	350
360	36.9	68.7	78.8	56.6	39.5	51.9	45.9	342	3.30	342	3.30	168	360
370	38.0	69.3	79.3	57.5	40.7	52.9	47.0	351	3.26	351	3.26	173	370
380	39.0	69.8	79.8	58.3	41.8	53.9	48.0	361	3.21	361	3.21	178	380
390	39.9	70.3	80.3	59.2	42.9	54.9	49.1	370	3.17	370	3.17	183	390
400	40.8	70.8	80.8	60.0	44.0	55.8	50.1	380	3.13	380	3.13	188	400
410	41.7	71.3	81.3	60.8	45.1	56.7	51.2	389	3.09	389	3.10	194	410
420	42.6	71.8	81.7	61.6	46.1	57.6	52.3	399	3.05	398	3.06	200	420
430	43.4	72.3	82.1	62.5	47.1	58.5	53.3	408	3.02	406	3.03	205	430
440	44.2	72.7	82.5	63.3	48.1	59.4	54.3	418	2.99	415	3.00	209	440
450	45.0	73.2	82.9	64.0	49.1	60.3	55.3	427	2.96	423	2.97	214	450
460	45.7	73.6	83.3	64.8	50.0	61.2	56.3	437	2.92	432	2.94	219	460
470	46.4	74.0	83.7	65.5	50.9	62.0	57.4	444	2.90	440	2.91	223	470
480	47.1	74.4	84.1	66.1	51.8	62.8	58.4	454	2.87	448	2.89	228	480
490	47.8	74.8	84.4	66.7	52.6	63.6	59.5	463	2.84	457	2.86	233	490
500	48.5	75.2	84.7	67.2	53.4	64.5	60.6	473	2.81	465	2.84	238	500
510	49.2	75.5	85.1	67.8	54.1	65.4	61.7	481	2.79	473	2.81	244	510
520	49.9	75.8	85.4	68.3	54.8	66.3	62.8	489	2.77	481	2.79	250	520
530	50.5	76.1	85.7	68.8	55.5	67.1	63.8	498	2.75	488	2.77	255	530
540	51.1	76.4	86.1	69.4	56.2	68.0	64.8	506	2.73	496	2.75	260	540
550	51.7	76.7	86.3	69.9	56.9	68.9	65.8	513	2.70	503	2.73	265	550
560	52.3	77.0	86.6	70.4	57.6	69.7	66.8	521	2.68	510	2.71	270	560
570	52.9	77.3	86.8	70.9	58.3	70.5	67.8	529	2.66	517	2.69	275	570
580	53.5	77.6	87.1	71.4	58.9	71.3	68.8	537	2.64	525	2.67	280	580
590	54.1	77.9	87.4	71.9	59.6	72.1	69.8	544	2.62	531	2.66	285	590
600	54.7	78.2	87.6	72.4	60.2	72.9	70.8	552	2.60	537	2.65	290	600
610	55.2	78.5	87.9	72.9	60.9	73.7	71.9	558	2.59	543	2.64	295	610
620	55.7	78.8	88.1	73.4	61.5	74.5	73.0	565	2.58	549	2.62	300	620
630	56.2	79.1	88.4	73.9	62.1	75.3	74.0	571	2.57	554	2.61	305	630
640	56.7	79.4	88.6	74.4	62.7	76.1	75.0	578	2.55	560	2.59	310	640
650	57.2	79.6	88.9	74.9	63.3	76.9	76.0	582	2.54	565	2.58	315	650
660	57.7	79.9	89.1	75.4	63.9	77.6	77.1	586	2.53	571	2.57	320	660
670	58.2	80.2	89.3	75.9	64.5	78.3	78.2	593	2.52	576	2.56	.....	670
680	58.7	80.5	89.5	76.4	65.1	79.0	79.2	601	2.50	581	2.55	.....	680
690	59.2	80.8	89.7	76.9	65.7	79.8	80.2	606	2.49	586	2.53	.....	690
700	59.7	81.1	89.9	77.3	66.2	80.6	81.3	611	2.48	591	2.52	.....	700
710	60.2	81.3	90.1	77.7	66.8	81.3	82.4						
720	60.7	81.6	90.3	78.1	67.3	82.0	83.5						
730	61.2	81.8	90.5	78.5	67.8	82.7	84.5						
740	61.6	82.1	90.7	78.9	68.3	83.5	85.5						
750	62.0	82.3	90.9	79.3	68.8	84.3	86.5						
760	62.5	82.6	91.1	79.7	69.3	85.0	87.5						
770	63.0	82.8	91.3	80.1	69.8	85.7	88.5						
780	63.4	83.0	91.4	80.4	70.3	86.4	89.5						
790	63.8	83.2	91.6	80.7	70.7	87.1	90.5						
800	64.2	83.4	91.7	81.0	71.1	87.8	91.5						
810	64.6	83.6	91.9	81.3	71.5	88.5	92.5						
820	64.9	83.8	92.0	81.6	71.9	89.2	93.6						
830	65.2	84.0	92.1	82.0	72.3	89.9	94.7						
840	65.5	84.2	92.3	82.2	72.7	90.6	95.7						
850	65.8	84.3	92.4	82.5	73.1	91.3	96.8						
860	66.2	84.5	92.5	82.8	73.5	92.0	97.9						
870	66.5	84.7	92.7	83.1	73.8	92.7	99.0						
880	66.8	84.8	92.8	83.3	74.1	93.4	100.0						
890	67.1	85.0	92.9	83.5	74.4	94.0	101.0						
900	67.4	85.1	93.0	83.8	74.7	94.7	102.0						
910	67.7	85.3	93.1	84.0	75.0	95.4	103.1						
920	68.0	85.4	93.2	84.2	75.3	96.0	104.2						
930	68.2	85.6	93.3	84.5	75.6	96.7	105.3						
940	68.5	85.7	93.5	84.7	75.9	97.4	106.4						
950	68.7	85.8	93.6	84.9	76.2	98.0	107.5						
960	69.0	86.0	93.7	85.1	76.5	98.7	108.6						
970	69.2	86.1	93.7	85.3	76.8	99.4	109.7						
980	69.5	86.2	93.8	85.5	77.1	100.0	110.8						
990	69.7	86.3	93.9	85.7	77.2	100.7	111.8						
1,000	69.9	86.4	94.0	85.8	77.4	101.3	112.8						

Thickness of Stock Required for Accuracy (Ten Times the Depth of Impression in Inches.)

VPN	VPN 10 kg.	VPN 50 kg.	Rc	15-N	45-N	BHN
200	0.017	0.038	0.072	0.015	0.040	0.186
300	0.014	0.031	0.059	0.012	0.032	0.135
400	0.012	0.027	0.050	0.009	0.026	0.098
500	0.011	0.024	0.044	0.007	0.022	0.080
600	0.010	0.022	0.038	0.006	0.018	0.068
700	0.0092	0.020	0.033	0.005	0.016	
800	0.0036	0.019	0.030	0.004	0.013	
900	0.0081	0.018	0.027	0.003	0.012	
1,000	0.0076	0.017	0.025	0.003	0.010	

Monotron tests at all hardnesses can be made on 0.018-in. stock. Scleroscope numbers vary with size, relations given are for 1-in. pieces.





Figs. 2 and 3—Relationship between hardness and wear resistance of a given material follow a definite curve. However, these two factors are related only in a general manner when a number of materials are considered.

alloy steels Group III, and hard plain carbon steels Group IV. The approximate ratio I:II:III:IV = 1:15:25:40, then expresses the relative mean values of wear in terms of the amount of metal removed in a given time.

Table II—Comparison of Vickers Hardness Numbers With Sawin Wear Numbers

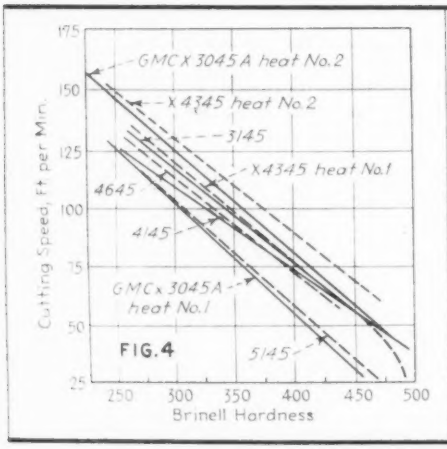
Metal Tested	Vickers Hardness DPH	Sawin Wear No.
Tungsten Carbide	1,050	2.5
Stellite	780	70
High Speed Steel	920	80
Tool Steel	830	130
Chrome Nickel Steel	360	180
Chrome Nickel Cast Iron	380	190
High Duty Cast Iron	250	210
Aluminum Nickel Bronze	120	220

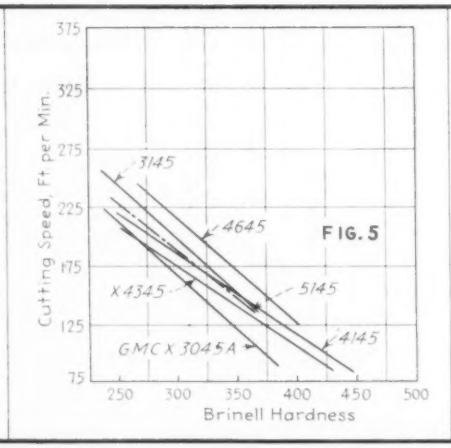
A comparison of the hardness versus wear relationship as based on test is made by J. W. Donaldson, in "Metallic Wear of Metals and Alloys," *Metallurgia*, 1942. He uses Sawin Wear Numbers which are defined as volumes in fractions of a cubic millimeter of impressions ground on test specimens by a standard disk under standard conditions. The test is explained in more detail by an article in *The Engineer*, 1939, Vol. 167, entitled "Testing metal for Wear by Friction Disks." Donaldson's data, see Table II, show the trend toward greater wear with increased hardness, and bring out the discrepancies mentioned above.

In general, hardness tests do not provide a reliable criterion for the evaluation of wear when different metallic materials are compared. For a metal of a particular composition, however, the greater its hardness, the more resistant it is to wear. This trend is shown by the data given in Table III which were published by S. J. Rosenberg in *A.S.S.T.*, 1931, Vol. 19 "The Resistance to Wear of Carbon Steels."

Table III—Wear of 0.81 Percent C Steel

Hardness Rc	Loss in Wt., Grams per 100,000 Kilogram-meters of work
58	0.08
50	0.20
45	0.30
40	0.48
36	0.75
31	1.20
26	1.80





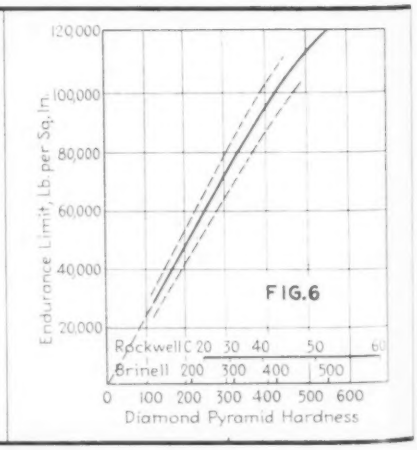


Fig. 4—Summary of machinability tests at 10 min. tool life, depth of cut 0.050 in., feed 0.0127 in., emulsion 1:20, heavy cut. Curves indicate difference in machinability of steels of identical analysis, but produced in different heats. Fig. 5—Summary of machinability tests at 10 min. tool life, depth of cut 0.0125 in., feed 0.0127 in., emulsion 1:20, light cut. Fig. 6—Approximate relation between hardness and endurance limit for steels.

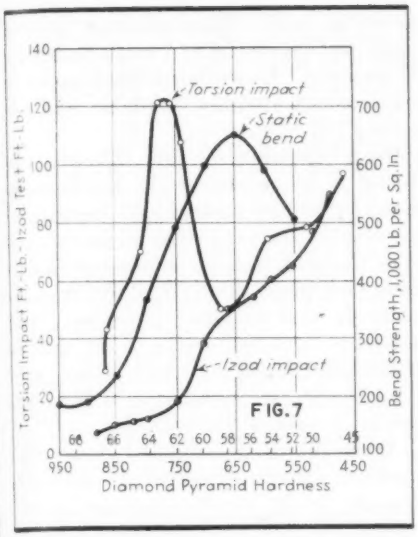


Fig. 7—Comparison of toughness test on 1.1 percent tool steel.

Hardness versus Machinability

The relationship between hardness and machinability is complicated not only by the composition, metallographic and crystallographic structure and other factors that have a bearing on the hardness-wear correlation, but also by additional factors such as the type and quality of cutting tools, speed of cutting, cutting oil employed. It is only where these factors are rigidly controlled for a steel of a given composition and even of a given heat that machinability varies directly with the hardness.

Fig. 4 shows this effect graphically on data taken from the work of O. W. Boston and L. V. Colwell, "Machinability of Six Alloy Steels," published in *Transactions ASM*, 1943. The great variability of the relationship is well illustrated by the displacement of the curves for GMC X3045A Heat 1 and Heat 2 which apply to steel of the same nominal composition but from different heats. This divergency is indicative of the variations in machining characteristics that occur in practice.

The effect of cutting rate is described by Fig. 5 for increased cutting speeds and lighter cuts. This graph brings out the difficulty of evaluating machinability quantatively from hardness data. All the variables influencing machinability must be fully reviewed before the hardness vs. machinability ratio can be employed to advantage.

Hardness versus Fatigue Strength

A useful correlation has been established between hardness and fatigue strength and endurance limit for steels. The available data on steel show a consistent relationship and are plotted in Fig. 6. They were obtained by R. E. Peterson and J. J. Lessells "Effect of Surface Strengthening on Shafts Having a Fillet or Transverse Hole," *Westinghouse Scientific Paper* #1157. The usual spread is indicated by the dotted line.

The relationship between hardness and fatigue strength may be upset by heterogeneities in the metal structure, by surface finish and by internal stresses to such a degree that erroneous conclusions may be drawn from these curves. It is therefore advisable to secure information regarding structure and previous treatment of the steel before using hardness—fatigue strength curves and charts as a basis for design.

Hardness versus Toughness

The toughness or impact resistance of metals depends on their structure and thereby on their hardness, as shown in Fig. 7. Fundamentally, toughness means a combination of ductility and strength with an absence of residual or microstresses. There is no basic relationship between toughness and hardness of the metal as both are influenced by several factors, such as cohesive strength, shear strength and ductility. Hardness-toughness curves must be derived separately for each metal or alloy.

The use of a variety of testing apparatus for the measurement of toughness in its various manifestations further complicates this situation. There are the different impact testing methods such as Charpy and Izod, the static bend test apparatus and the torsion impact testing machines. Fig. 7 shows decided variations in toughness over certain portions of the curves for the 1.1 percent carbon-steel illustrated. These discrepancies may be caused by the divergent means of loading in each test, which result in differing proportions of cohesive strengths, ductility and shear strengths being measured by each mode of testing. All three tests reveal a trend for the toughness to increase as hardness decreases.

Practical Application of Hardness Tests

The simple, non-destructive hardness test offers a rapid check on quality and uniformity of heat-treatment and on conformity with specifications. For instance, decarburization causes a lowering of surface hardness, fatigue strength and wear resistance. Hardness tests reveal this condition. A typical decarburization curve is shown in Fig. 8 which was obtained by grinding a slope on the work and performing successive hardness tests. The depth of carburized, nitrided, or cyanided cases can be measured as easily, if the plane of testing is

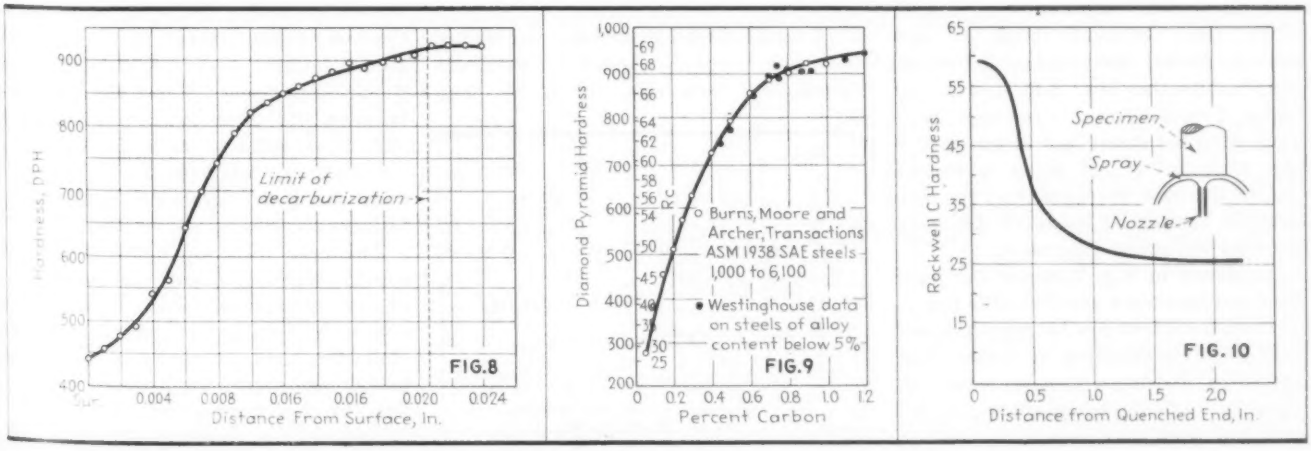


Fig. 8—Amount of decarburization on a forged Mn-Mo steel, 0.07 percent C, 1.25 Mn, 0.2 Mo. Forged from 4 in. cube to 1½ x 7 16 in. flat. 10-kg. DPH test. Fig. 9—Determination of carbon in a steel which is hardened to optimum hardness, or optimum hardness obtainable from a steel with given carbon content. Fig. 10—Typical Jominy hardenability curve of NE 9442 steel after normalizing and quenching from between 1,450 and 1,600 deg. F.

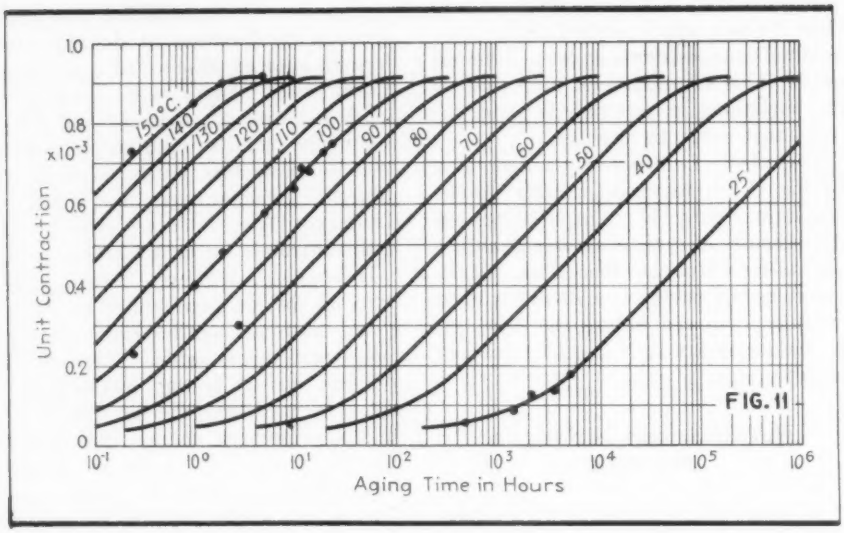


Fig 11—Effect of aging temperature on contraction of hardened SAE 52,100 steel.

similarly ground at a slight angle with the surface.

The use of optimum hardening temperatures is essential for the production of the most favorable structure for both hardening and subsequent heat-treatments. In general, it is the temperature at which maximum hardness of the steel is obtained "as-quenched."

One method for determining the optimum hardening temperatures of alloy steels containing over 2 percent of alloying constituents consists of subjecting the heat-treated steel for an hour to temperatures of —60 to —150 deg. F. If a substantial increase in hardness takes place, the hardening temperatures used was too high. If the as-quenched hardness is low, and the sub-zero treatment fails to increase it, it is possible that too low a hardening temperature or too slow a quenching rate was used. Low hardening temperatures are investigated by rehardening the steel at a quenching temperature 45 deg. F. higher than previously used. If hardness increases, the original hardening temperature was low. Too slow a cooling or quenching rate is revealed by requenching the steels in a faster quenching medium. If all these treatments fail to increase the hardness, chemical analysis should be made to determine the composition of the steel.

As shown in Fig. 9, where the maximum hardness of a given steel is known, its carbon content can be approximated.

In the determination of critical cooling rates, hardness measurements can serve to indicate whether or not this rate has been exceeded.

The effectiveness of quenching media and the critical size of steel can be determined by hardness tests. Under critical steel size is understood the maximum cross-section which can be hardened-through by a particular quenching medium. It is determined by observing the depth to which a standard steel specimen will harden when its surface is cooled at a definite rate. This is rapidly becoming a standard by which steels are specified, the depth of hardening provides a more satisfactory criterion than chemical composition. Fig. 10 illustrates "Jominy Curves" which are expressions of hardenability, obtaned by hardness measurements.

Fabrication and Performance Of Metals

Hardness tests are important both during fabrication and on the finished product. They serve to overcome manufacturing difficulties and to gage behavior in service, and provide engineers with a rapid means of checking performance on the production line and in service. In the following some examples are cited from a wealth of data.

A metal stitching machine was failing to stitch properly capacitor containers fabricated from thin sheets of deep drawing steel. Measurements proved stock to be too hard by 7 to 10 Rockwell B numbers. No further difficulties were experienced after the hardness was adjusted.

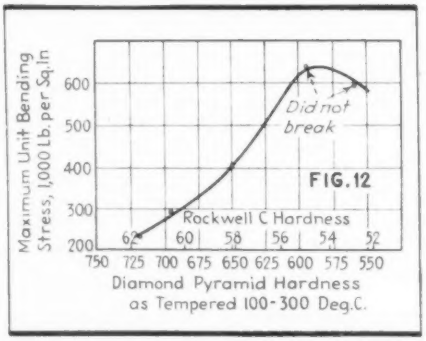


Fig. 12—Bending strength of tool steels. Hardened at 1510 deg. F., oil quenched and tempered 30 min. Size 0.25 x 0.375 x 2.625 in Gage 2 in.

Slow growing of die blocks was found to be caused by the transformation of residual austenite at room temperatures. By subjecting them to sub-zero temperatures, an increase in hardness took place that indicated the presence of this residual austenite. The tendency of some steels to do this is illustrated in Fig. 11 by a chart prepared by Dr. W. A. Johnson of Westinghouse Research Laboratories.

When die parts machined from high-carbon, high-chromium steel broke frequently under service stresses, it was shown that the heat-treated die at 60 Rockwell C was 6 numbers too hard for maximum toughness as estimated from bend test data, see Fig. 12. Revision of hardening specifications eliminated failures.

The rapid wearing of a carburized die block caused a sharp decrease in die life. Hardness tests on a cross-section revealed that the case was so shallow that three or four regrinds exposed the softer underlying material. The heat-treatment was modified to provide a deeper case and resulted in a longer life of the dies.

Frequently hardness tests merely provide a clue to a defect which must be isolated clearly by more extensive investigations, such as microscopic studies of the metal structure. For example, pinion gears for railroad motors, were failing in service from fatigue at the base of the teeth. Hardness tests revealed that the metal at the root of the tooth was not hard enough. Further hardenability and microscopic studies proved that the steel used was not sufficiently hardenable due to its extremely fast critical cooling rate, conditions that prevented hardening in depth. Because of the low fatigue strength of unhardened steels, failures occurred through these unhardened areas. When the composition of the gear steel was modified slightly in order to increase its hardenability, the metal at the base of the gear teeth hardened properly and fatigue failures ceased.

The ease with which hardness tests can be carried out and the importance of the relationship between hardness and various other mechanical functions make the hardness tester an important tool in any plant. Unfortunately its reliability deteriorates through years of heavy service. Regular inspection and calibration of hardness testers is therefore an integral part of their practical application, so that readings will be reliable and the greatest possible use made of this valuable tool.

Formed Sheet Metal Parts Classified by Shape—II

MARK P. MEINEL
Production Design Engineer
Lockheed Aircraft Corporation

Continuing the discussion on classification of formed sheet metal parts begun in the March issue. Critical design factors are listed for contoured flanged parts of non-uniform cross-section and for double curvature parts. Deep and shallow recessed parts will be analyzed in the third part of the series to appear in May. Forming methods and machines and their influence on part design will be described in a concluding article.

THE design and production of formed sheet metal parts have been simplified and improved by classifying these parts on the basis of their finished shape. As stated in Part I, this classification was done largely by Dr. George Sachs, Case School of Applied Science, under the direction of the National Research Committee and the War Metallurgy Committee. The classification has been made more usable in its application to aluminum alloy parts by discussions of the critical factors, forming methods and equipment that should be considered in designing 23 defined classes of parts.

Types 1 and 2, dealing with singly curved parts and curved sections, were discussed in March PRODUCT ENGINEERING. Type 3, dealing with parts having contoured flanges and non-uniform section, and Type 4, dealing with smoothly contoured parts having double curvature, are covered here. Types 5 and 6 on deep and shallow recessed parts will be discussed in Part III of this series of articles.

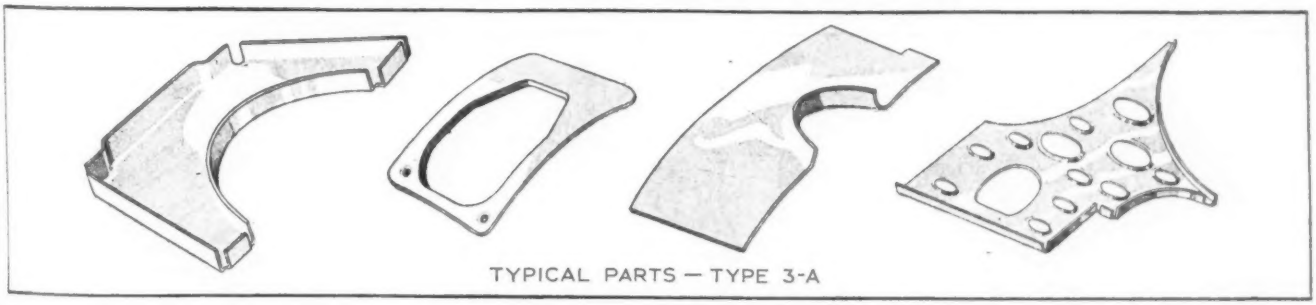
TYPE 3—CONTOURED PARTS OF NON-UNIFORM CROSS-SECTION

DEFINITION: Characterized by flat or nearly flat web with concave and/or convex profile bounded on any or all sides by flanges.

In forming a curved flange the metal must either shrink or stretch depending upon whether the flange is concave or convex. The measure of strain is expressed as a ratio of the radial movement of the flange edge to its radius before forming, while angular springback is decreased by the curvature of the flange. The elastic recovery of the flange parallel to the flange edge creates the so-called linear springback, which causes considerable distortion in parts that are formed in hard stock.

CRITICAL DESIGN FACTORS FOR TYPE 3 PARTS

Class A—Stretch flange parts characterized by flanges on concave profile and sometimes combined with straight flanges.



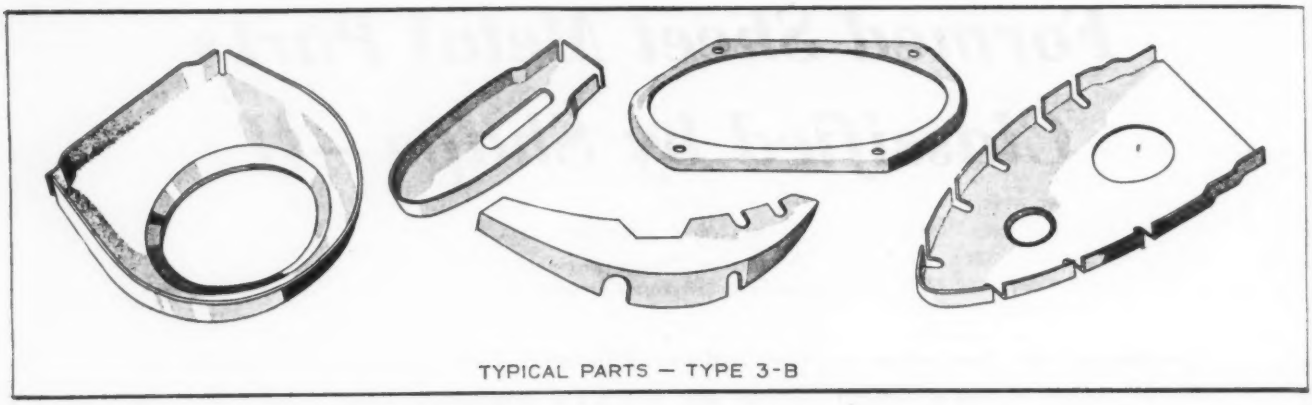
TYPICAL PARTS — TYPE 3-A

1. Minimum radii for all bends should conform to values given under Type 1-A, March PRODUCT ENGINEERING.

2. Flange width must meet the minimum values specified for rubber forming, as given under Type 1-A parts.

3. Geometry of the flange must be such that the stretch will not exceed the limits of the material. The standard elongation for stretch flanges is 10 to 12 percent for 24SO, 52SO, and 61SW alloys. Strains ranging to more than 20 percent are permissible in 24SO when blank edges are polished; the radius of curvature is less than 1 in. or the segment angle less than 60 deg. It is good practice to use 24ST Alclad for stressed parts wherever contour permits in order to avoid distortion caused by heat-treatment.

4. Cut-outs made to bring the stretch within limits of rubber forming must extend over the full length of the stretch area. *(continued on next page)*



TYPICAL PARTS — TYPE 3-B

Class B—Shrink flange parts characterized by flanges on convex profile and sometimes combined with straight flanges.

1. Minimum bend radii and minimum flange widths are the same as for Type 1-A.

2. High shrink must be alleviated when flanges are rubber formed. Short flange segments with free edges, as shown in Fig. 4, improve formability by relieving compressive strains.

3. Thin gages and hard stock do not shrink readily and should be avoided. The best material is 3SO, then 24SO, 52SO, and 61SW in descending order of formability.

4. Formability depends on the method of fabrication. For rubber forming the maximum strain for 24SO is 2 percent or less if wrinkling is to be avoided. and 3 to 4½ percent if slight wrinkles are allowed. Wrinkles can be removed by hand forming. With 24ST Alclad, slight wrinkles occur when strains are 1 percent or less and bad wrinkling occurs with greater strains. By mechanical means 24SO Alclad can be shrunk more than 25 percent without wrinkling and 24ST up to 10 percent.

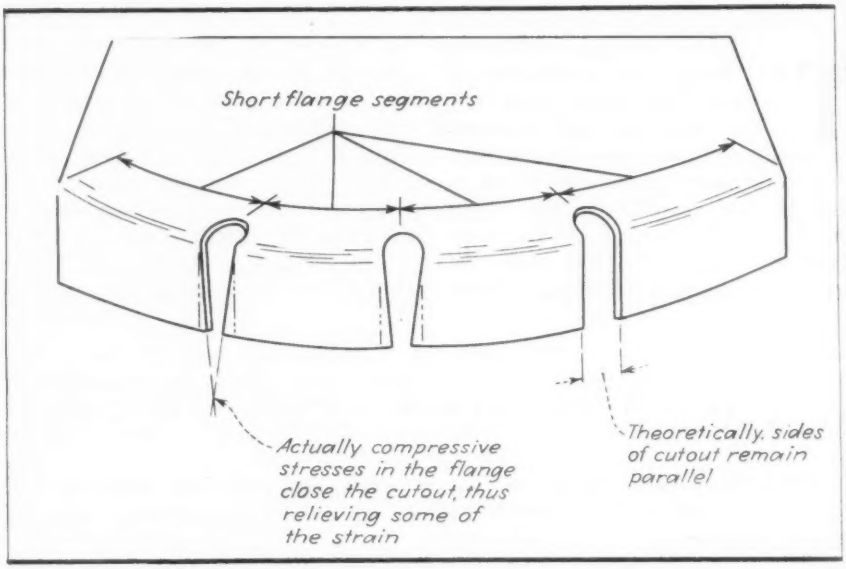
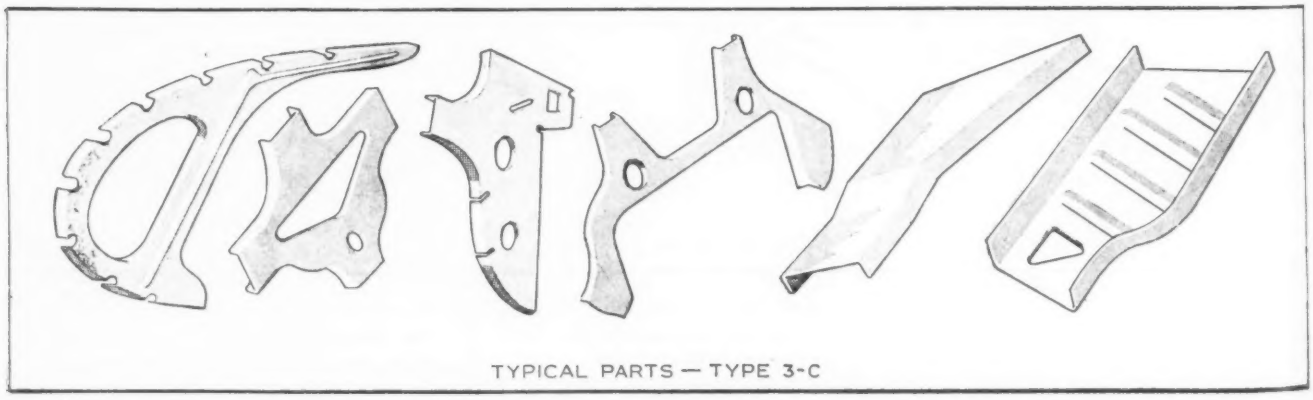

Short flange segments
Actually compressive stresses in the flange close the cutout, thus relieving some of the strain
Theoretically, sides of cutout remain parallel

Fig. 4—Short flange segments with free edges improve formability by relieving compressive strains. Excess material closes the cutout instead of wrinkling the flange.

Class C—Combined stretch and shrink flange parts characterized by flanges on both concave and convex profiles sometimes combined with straight flanges.



TYPICAL PARTS — TYPE 3-C

1. Forming considerations affecting bend radii, flange widths, maximum strain, and related forming details, are the same as those for Classes A and B, given above.

2. A flange having adjacent stretch and shrink areas can be formed to a severe contour when segment angles and/or the contour radii are small; that

is, under 60 deg. and less than 4 in. radius.

3. Shrink areas on rubber formed parts having reverse contour are always critical and the order of choice of material is the same as for Class B.

4. Concave or stretch flanges having more than 100 percent theoretical elongation can be formed by special techniques that reduce actual strains to 25 percent of theoretical value, but increase the cost of fabrication considerably.

ACCEPTABLE FORMING METHODS FOR TYPE 3 PARTS

Three methods, rubber forming on a hydropress, forming on single or double action dies, and forming on a drop hammer, are suitable for each class of Type 3 parts.

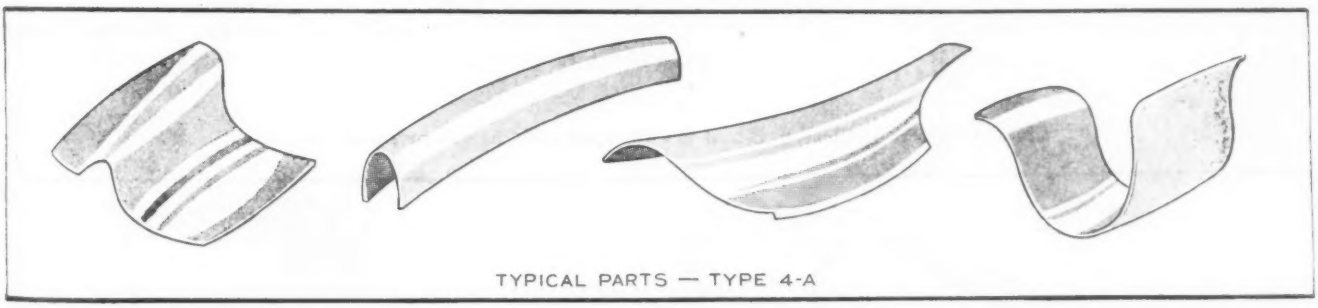
TYPE 4—DOUBLE CURVATURE SMOOTHLY CONTOURED PARTS

DEFINITION: Parts are characterized by contours composed of flowing curves that merge without apparent break in the same or opposite directions. Although this type can be formed on various equipment, the majority of parts are especially suited for stretch forming, which permits the use of hard stock and thus avoids heat-treat distortion. The use of 24ST material is preferred to 24SO because the latter tends to neck down locally, thus curtailing the overall strain.

If severe contour is necessary, additional elongation can be secured in a second operation by heat-treating the partially formed blank and restretching in the "as quenched" condition. The amount of stretch taken in this second operation may be 75 percent of that taken in the first operation after this heat-treatment.

CRITICAL DESIGN FACTORS FOR TYPE 4 PARTS

Class A—Parts having large radii of curvature around one axis and relatively small radii of curvature around a perpendicular or nearly perpendicular axis.



TYPICAL PARTS — TYPE 4-A

1. The maximum strain determined by the difference between the maximum and minimum contour lengths of the part should be within elongation limits of the material as given in Table VI.

2. Materials suitable for stretch forming are 24ST Alclad and 61SW for parts formed in one operation, and 52SO and 24S "as quenched" for parts requiring two or more operations. For drop hammer and double action die forming, suitable materials are 24SO, 52SO and 61SW for parts requiring one or more operations.

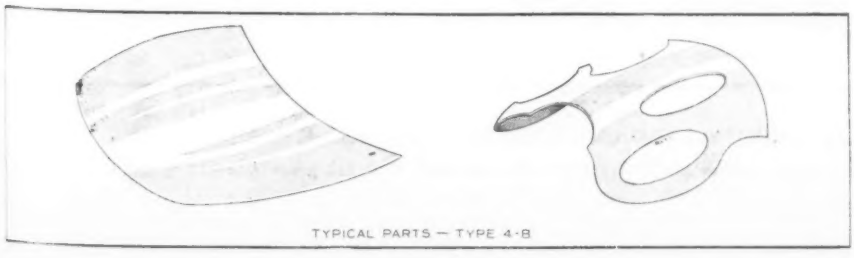
3. Bend radii can be as small as ½ in. if forming is done with drop hammer or double action die, but preferably should be 1 in., which is minimum for stretch forming.

4. Parts that taper end to end are suitable for stretching, but a larger amount of flash will result because additional metal is needed to make the blank symmetrical for forming.

Table VI—Elongation Limits of Aluminum Alloys

Material		Avg. Elongation in 42 in., %	
		Sheared edges	Polished edges
Gage 0.032	24SO	8.4	10.8
	24ST	5	7.3
	61SW	5.8	12.5
	52SO	10.5	11.6

Class B—Parts having large radii of curvature in two directions; centers of curvature on same side of sheet.



TYPICAL PARTS — TYPE 4-B

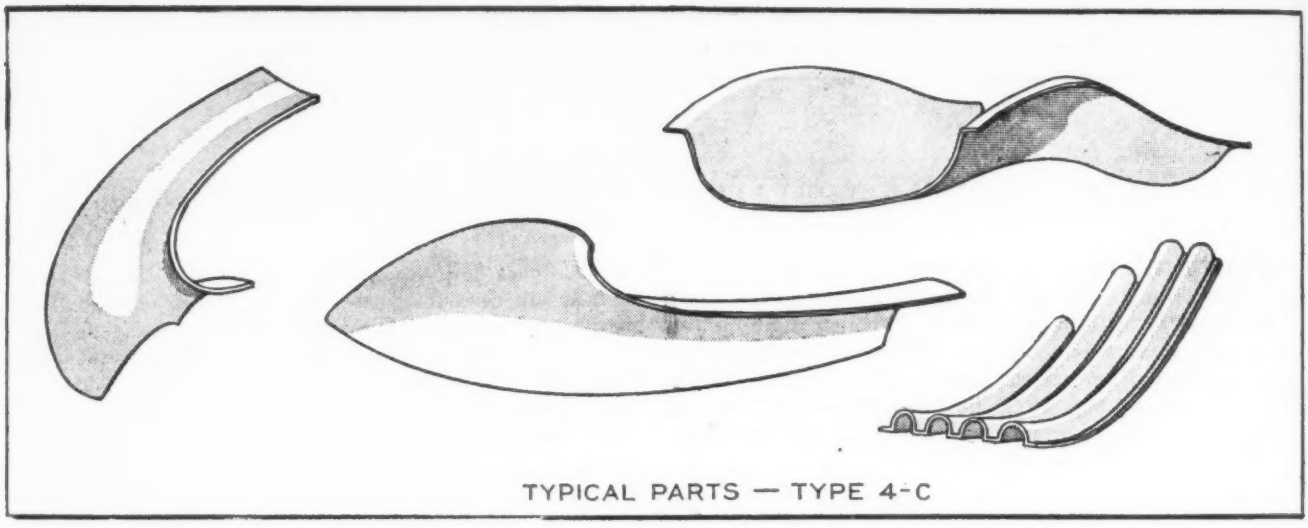
1. Data on maximum stretch, selection of material and bend radii are, in general, the same as for Class A.

2. Parts that deviate only slightly from flat sheet are difficult to form accurately because of high friction around the edge of the die and because buckles tend to form along the center of the blank parallel to the direction of

stretching. Buckling can usually be corrected by proper die development.

3. Heat-treat distortion is a major problem in shallow double curvature parts and should be avoided when possible by using 24ST, 61SW or 52SO alloys. When 24SO is used, the part must have a restrike or sizing operation after heat-treatment.

Class C—Parts having opposite contours in two directions; centers of curvature on opposite sides of the sheet.



TYPICAL PARTS — TYPE 4-C

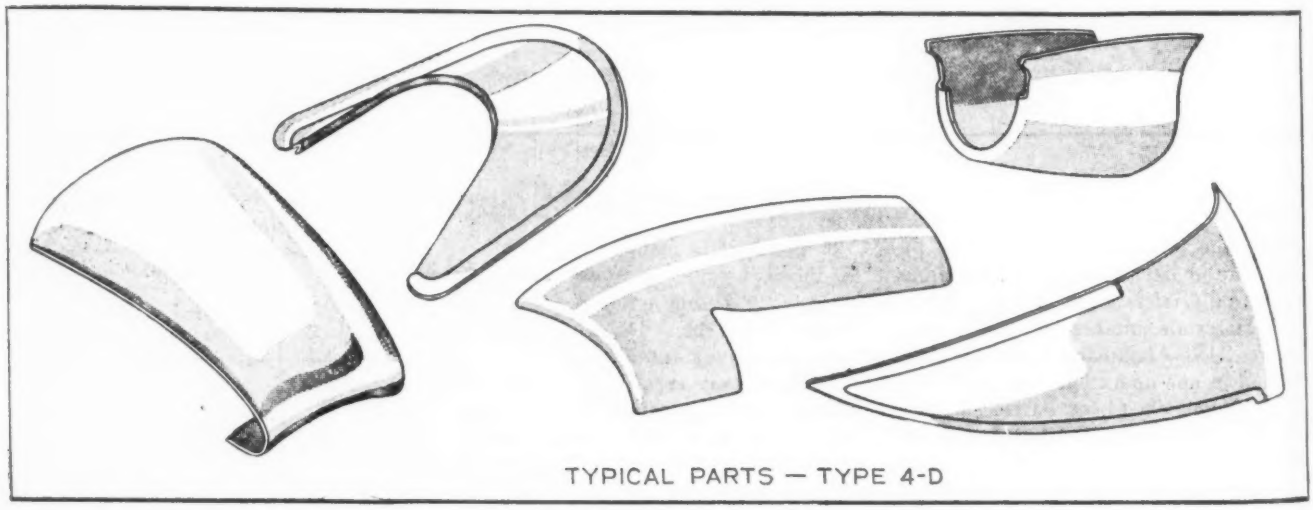
1. The forming limit usually depends on the transverse contour of the part and the maximum stretch must not exceed the limits given for Class A. However, if the maximum contour is at the edge of the part, the formability is reduced because of edge effect.

2. The saddle should be shallow, not exceeding the maximum depth-chord ratio of 0.09 to prevent wrinkling difficulties.

3. If the part has several reversals of contour, as in a corrugated part, the depth-pitch ratio of these reversals should not exceed 0.22.

4. The selection of material and the conditions regarding heat-treat distortion are similar to those of Class A.

Class D—Parts of Class A, B and C with small radii at one or several edges.



TYPICAL PARTS — TYPE 4-D

Generally two operations are required in forming parts with small radii at the edge, one to form the major contour and the second to form the sharp radius, which should be proportioned so that the amount of shrink does not exceed 4 to 6 percent. If the sharp radius produces a stretch flange, the maximum width can be 1/20 of the profile radius of the part periphery when the flange is turned through 180 deg. Only ductile alloys should be used for this class.

ACCEPTABLE FORMING METHODS FOR TYPE 4 PARTS

Forming methods are the double action die on all four classes, stretch forming for Classes A, B and C, drop hammer for A and C, and rubber forming on Classes B and D.

P-80, Jet-Propelled, Claimed "Fastest in World"

LOCKHEED'S new and secret fighter plane proves to be the P-80 "Shooting Star," powered by a single jet engine said to develop 3,000 hp. That the Army Air Forces, which recently announced the name and number of its first jet combat plane, along with a few performance statistics, regards the P-80 highly is evident from the fact that the new ship has displaced some production of the other excellent Lockheed fighter, the P-38, at Lockheed's Burbank, Calif., plant. The P-80 also will be produced at North American's Kansas City plant.

AAF claims that the P-80 is the "fastest fighter in existence." A new wing design, with an extremely thin leading edge, is one of several aerodynamic innovations which help solve problems of compressability encountered at or near the speed of sound. A hydraulic booster for the ailerons and electrically-controlled flaps contribute to the plane's maneuverability, which pilots rate highly. Absence of propeller, radiator, oil cooling system, superchargers and carburetor, along with the numerous and complex controls, and other pieces of equipment, render the P-80 a simple plane to build, service and fly.

AAF officials sent Lockheed a jet engine in July 1943, and asked that a suitable airframe be designed for it. Lockheed and Army engineers designed, built and flew the new machine in 143 days, later adapting to it the General Electric jet engine. The engine is larger and more powerful than the jet engines installed on the P-59A, AAF's first jet propelled plane. The new jet attachment enables the delivery of more than twice the power obtainable through the first jet GE built for the Army. The engine can be removed in a few minutes, whereas the removal of a gasoline engine from a fighter plane takes hours.

The P-80 has a pressurized cabin, is equipped with fittings to which a "G suit" can be attached. "G suits" are trousers fitted with strategically-located bladders which inflate automatically and prevent the rush of blood to the extremities in fast turns or sharp pullouts.

Ceiling is "well above that of propeller-driven planes" (about 40,000 ft.), according to Lockheed officials who add that the P-80 "operates over any of the ranges that conventional pursuit ships of today are called upon to perform."

New Launching Device for Airborne Rockets

AIRBORNE ROCKETS are growing more powerful, with a five-inch, high-velocity projectile fired from a "zero" rail replacing the earlier 4.5 in. rocket which was fired from steel, plastic or magnesium "bazooka" tubes slung under each wing.

The new launching device cuts down air resistance considerably. It consists of two streamlined studs per rocket which project from the lower surface of the wing and support the 140-lb. projectile at two points. Thus, little drag remains after a rocket has been fired. The new projectile is about six feet long and will penetrate thick armor or heavy reinforced concrete. It is particularly effective against shipping and such land obstacles as pill boxes or machine gun nests. It is quite accurate at short range, 1,000 to 500 yards.

Ford Robot Engine Improvement on Nazis'

THE IMPULSE JET ENGINE which the Army Air Forces is procuring for its robot bombs from the Ford Motor Company, is an improvement on its Nazi prototype, according to AAF officers who have been explaining away their failure to develop such a weapon before the Germans for months.

The Ford engine is a tube of $\frac{1}{8}$ in. steel into which air is forced by forward motion of the projectile on which it is mounted. It flows through 256 reed-type valves mounted in a grille of die-cast aluminum elements which form the valve seats. Nozzles project fuel into the air stream as it enters three openings behind the grille. First ignition is by spark plug, thereafter by tube heat.

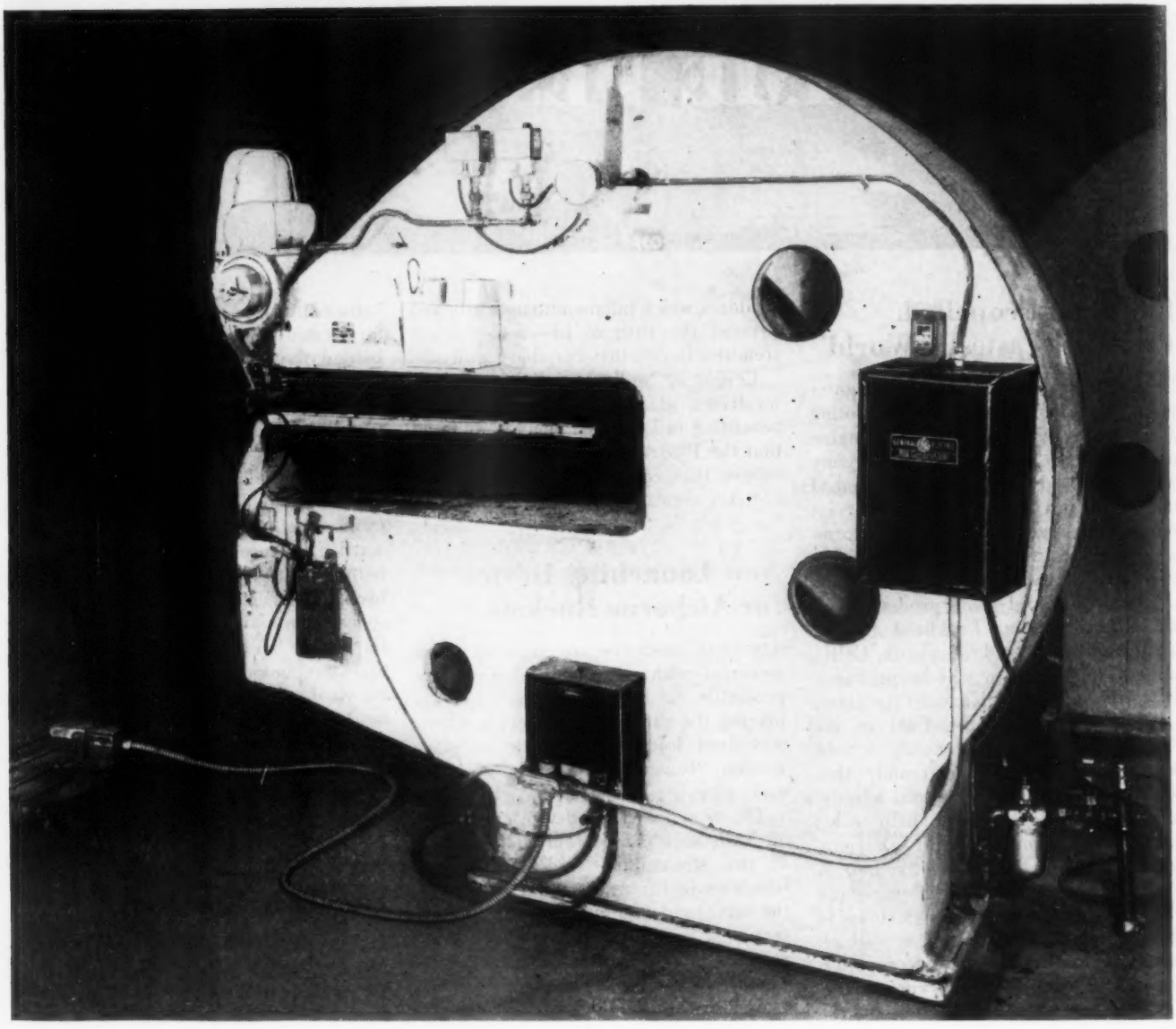
At top speed, a smooth thrust is attained by the completion of about 42 impulses per second. Valves are actuated automatically by pressure reversals in the tube and do not control the firing cycle. The bomb must be projected forward at a speed of 140 to 150 m.p.h. before the air stream entering the motor becomes sufficient to actuate valves. Top speed is around 400 m.p.h. To warm up the engine before launching, three pitot tubes are mounted in front of the grille, increasing the fuel flow as the air stream increases. An aneroid barometer control governs the fuel mixture in relation to the bomb's altitude. Fuel consumption is roughly one mile per gallon.

NACA Seeks Funds For Basic Research

BY FAR the greatest part of the research done by the Army Air Forces by the National Advisory Committee for Aeronautics is on specific design and specifications problems posed by AAF, and only a little less than 10 percent of NACA's activity is on basic research, Dr. Jerome C. Hunsaker, NACA chairman, told a House appropriations subcommittee recently.

Hunsaker termed it "regrettable" that NACA has neither the staff nor the facilities to maintain basic research even while conducting vastly-expanded work for the Air Forces. He declared that the question of supersonic aerodynamics underlies the whole field of aerial weapons development and said NACA will have to pursue basic research in this field regardless of the accumulation of requests for solutions of specific problems.

For the fiscal year ending June 30, 1946, NACA seeks slightly more than $26,000,000. It now employes 6,390 persons and anticipates increasing its staff to 7,680. Many of these are in the Army or Navy but have been assigned to NACA in lieu of operational duty.



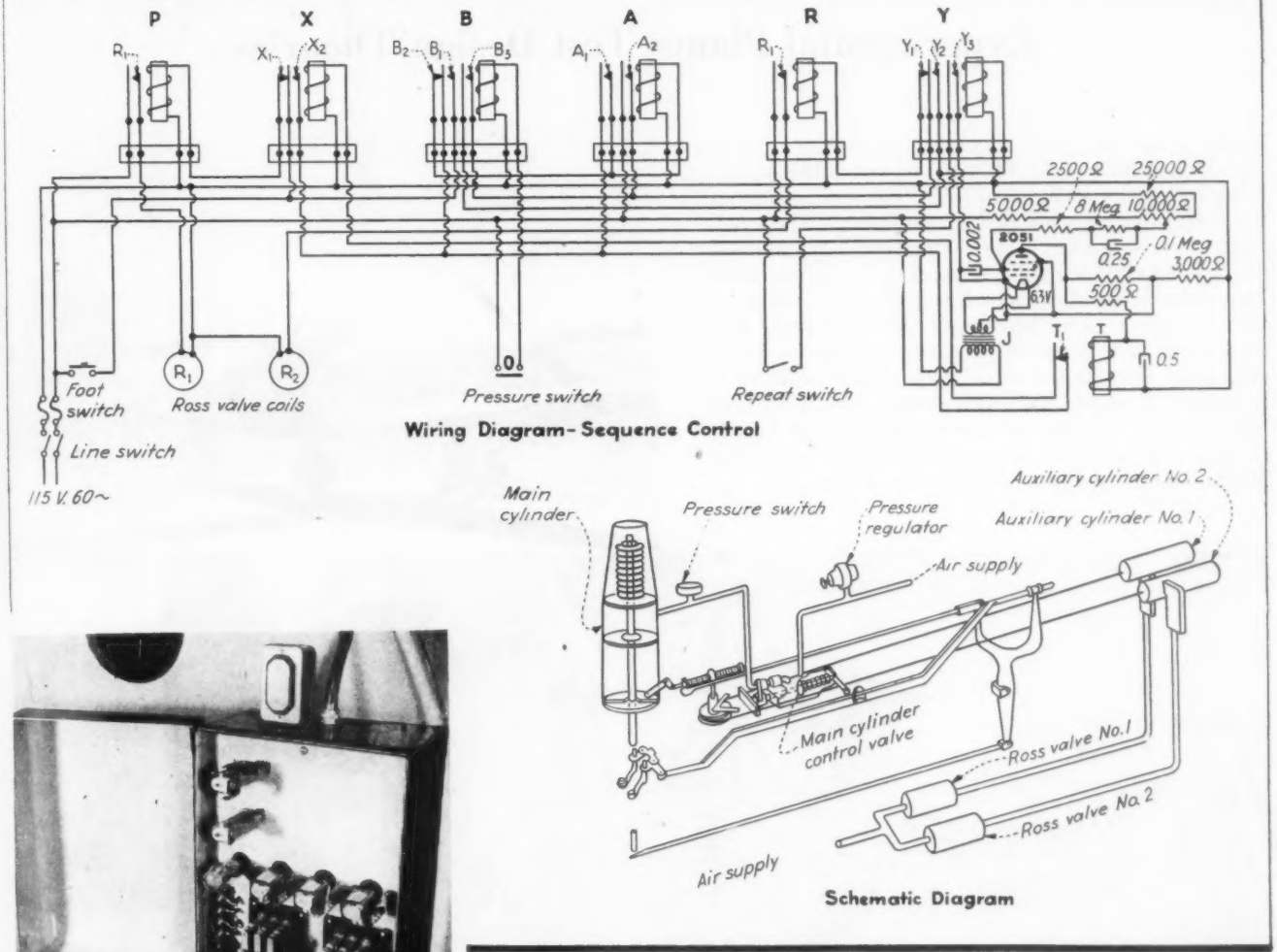
Pneumatic-Electronic Sequence Control Developed for Flush Riveting Machine

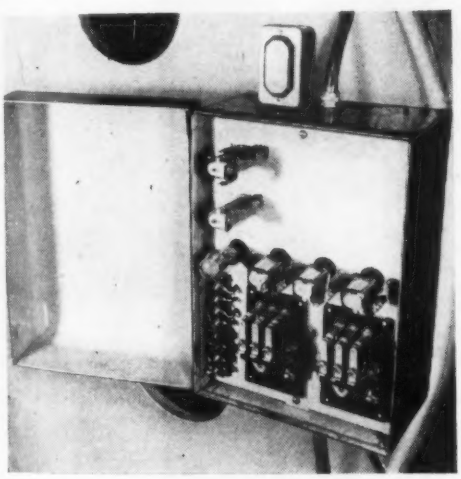
OVERALL EFFICIENCY of Model 2002 Erco Riveters has been greatly increased at Consolidated-Vultee Aircraft Corporation, by means of a pneumatic-electronic sequence control invented by Walter Mandel, electrical engineer. Prior to the development of this unit, it was necessary for machine operators to control complicated flush riveting processes by foot pedals. Since the speed and accuracy of each riveter depended largely on the alertness and good judgment of the operator, mistakes were occasionally made—causing losses in time and materials and increasing expenditures for replacement of machine parts. Electronic timing reduces errors caused by poor operator response or by fatigue.

With manual controls, a single Erco 2002 riveter can handle about 10 normal-sized airplane panels in an eight-hr. day. With the new sequence control unit, the same machine will turn out approximately 12½ normal-sized airplane panels in an 8-hr. day.

By actuating a series of electrical circuits in a suitable sequence, the Mandel unit makes it possible to actuate various parts of an Erco machine by a single electric pulse derived from a pressure switch.

Observations over a period of six months have revealed that a manually-operated Erco machine requires parts replacements costing approximately $250.95, while an automatically-controlled Erco machine requires parts replacements costing about $111.65. Each unit can thus more than pay for itself with savings in the cost of parts alone, which amounts to approximately $139.50 every six months. To date, there have been no machine failures caused by electrical defects.





When the foot switch is closed, relay *P* is energized, contacts *P*-1 close, energizing the solenoid, and opening Ross valve No. 1. Air entering cylinder No. 1 actuates the shift mechanism—moving the die button into the punching position, locking the punch, shifting the piston stop block under the main piston, and opening the main cylinder control valve.

Air entering the main cylinder drives the plunger down into the die bottom, whence it continues to descend, contacting the material and forcing the die over the punch until it is halted by the piston stop block. When air pressure in the main cylinder increases sufficiently, pressure switch *O* closes, energizing relay *B*, and through a series of contacts, de-energizing relay *P* and exhausting air from auxiliary cylinder No. 1.

When air pressure in auxiliary cylinder No. 1 is reduced, the spring in the main cylinder control valve opens the exhaust for the main cylinder; then the main cylinder spring returns the plunger to its normal position. Pressure switch *O* opens de-energizing relay *B* and energizing relay *A*, and the solenoid of Ross Valve No. 2. Air then enters auxiliary cylinder No. 2 and actuates a shift mechanism—moving the rivet shoe into alignment with the rivet set, removing the main piston stop block and punch lock, and opening the main cylinder control valve.

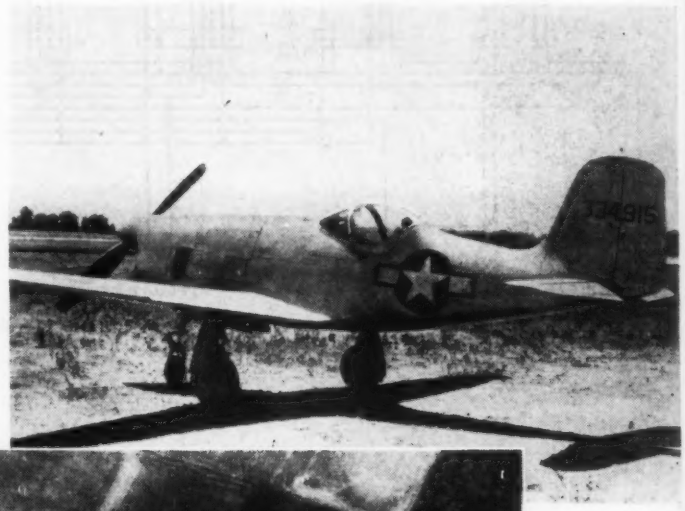
Air entering the main cylinder moves the piston down, causing the rivet set to enter the rivet shoe and guiding the rivet shoe and rivet to a position directly above the punch. Continuing to descend, the rivet enters the work and pushes the punch out of the work ahead of it. The punch comes to rest at the top face of the anvil, and at the extreme end of the stroke the rivet head is formed. When the air pressure in the main cylinder is sufficiently high, pressure switch *O* closes, and the cycle de-energizes the solenoid in Ross Valve No. 2, to exhaust auxiliary cylinder No. 2. When air pressure in this cylinder is reduced, the spring in the main cylinder returns the plunger to its normal position.

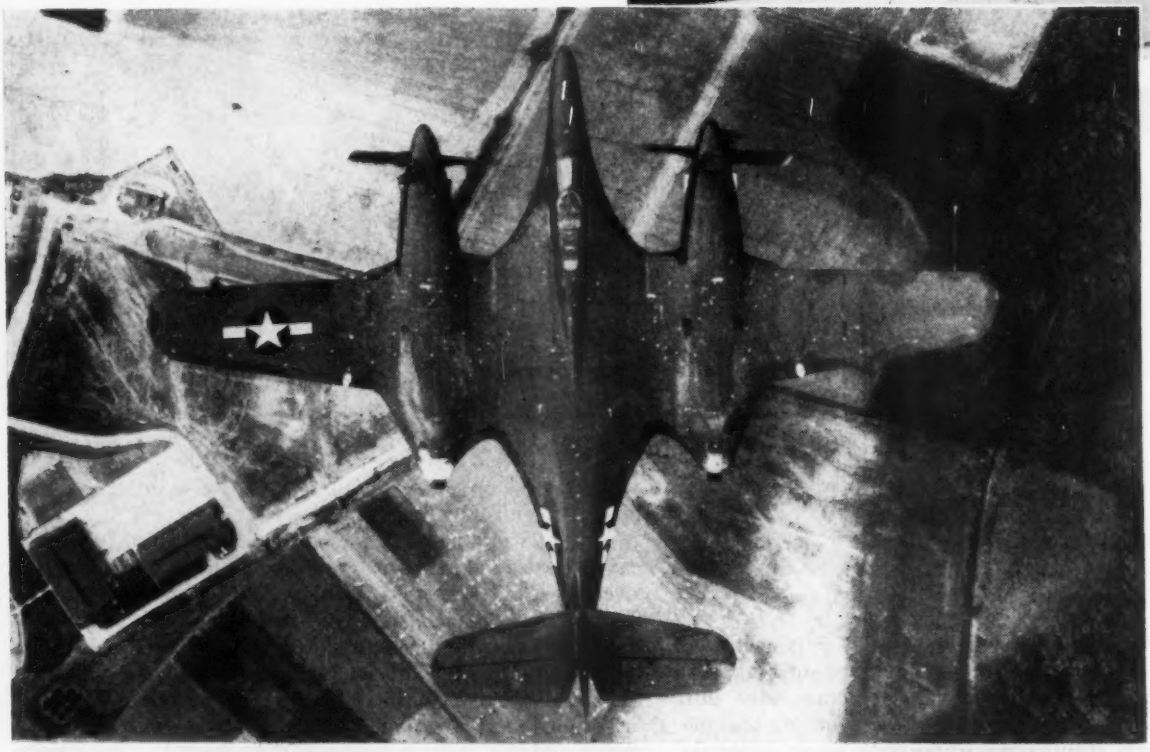
If the foot switch remains closed and the repeat switch remains open, the cycle of operation is complete and the machine becomes inoperative. If the foot switch is open relays *X*, *A*, and *Y* return to their normal positions. If the foot switch remains closed and the repeat switch is closed, the energizing of relay *Y* causes the timing circuit to become operative. When the plate current of the thermionic tube reaches a value sufficient high to operate relay *T*, relay *A* is de-energized. Relay *Y* is then opened and the timer circuit connected.

This sequence of operations will continue as long as the foot and repeat switches remain closed. The speed of the operation depends upon the setting of the potentiometer which controls the time constant of the timer circuit.

Experimental Planes Test Design Theories

THREE COMPARATIVELY UNKNOWN TYPES OF PLANE, the XP77, XP67 and the XP54 are on test at the Army's flying laboratory at Wright Field. The small plane, at the right is an all-wood fighter developed by Bell Aircraft. Performance is not equal to conventional fighters and vibration tends to crack the wood structure. The plane shown is powered with an in-line Ranger V-770 engine. The bat-winged XP77, center, was designed to test flying-wing theories and carries heavy armament. At the bottom is shown Vultee's XP54, a twin-boomed pusher type with unique design features including an elevator for getting in and out of the cockpit. The pilot's seat is electrically lowered. Magnesium is used extensively in this design.





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Production processes and methods

FOR PRESENT AND POSTWAR USES

An editorial review

of various production processes,

their inherent characteristics and features, and their

influence and effect upon the design

of products and machines.

PRODUCT ENGINEERING ★ APRIL, 1945

PRODUCTION PROCESSES

Casting Methods	SAND PERMANENT MOLD CENTRIFUGAL PRECISION DIE CASTING
Forming Methods	FORGING EXTRUDING POWDER PRESSING STAMPING AND DRAWING FLAME CUTTING
Assembly Methods	WELDING BRAZING
Heating Methods and Surface Treatment	INDUCTION HEATING DIELECTRIC HEATING SHOT PEENING

CASTING METHODS

SAND CASTINGS

Sand castings can be made of iron, steel, aluminum, copper alloys and all other metals except wrought iron.

Tooling Costs are exceptionally low, often negligible. A wooden pattern and possibly also coreboxes are all that is required, making this process highly economical for small lot production.

Dimensional Accuracy. Sand castings can be produced commercially ranging from plus or minus $\frac{1}{32}$ in. to plus or minus $\frac{1}{16}$ in.

Size Limitations. Sizes of sand castings range from parts weighing a fraction of a pound to machine frames weighing more than 100,000 lb. In general, thin sections are difficult to cast. Minimum thicknesses of wall vary for the different metals and the area of the wall.

Design Features. Sand castings can be of irregular shape and complicated form. Holes and interior cavities can be cast by the use of cores. Bolt holes can be cored and later opened to final size by drilling and reaming.

PERMANENT MOLD CASTINGS

In general, the same features that apply to sand castings also apply to permanent mold castings. Dimensional tolerances are considerably closer so that in some instances machining is not necessary.

The same metals and alloys that can be cast in sand can be cast in permanent molds which are made of metal sometimes faced with a refractory material. If sand cores are used in conjunction with metal molds the process is called semi-permanent mold casting.

Metal molds cost more than wooden patterns. Tooling costs are relatively high. Hence, permanent molds are generally used only when savings in machining and lower production cost offset higher tool costs.

Size Limitations. Because of the size, weight and cost of a metal mold, large pieces are not cast by this process. A typical example of the maximum size in which such castings are made are the cylinder blocks of automobile engines.

Design Features. In addition to their smooth surfaces and close dimensional tolerances, permanent mold castings have a finer grain structure than that of castings made in sand molds because of the more rapid cooling of the metal in contact with the mold.

Slush Castings are a type of permanent mold casting used in the manufacture of cast chandeliers and similar products. Molten metal is poured into a vessel shaped mold and after allowing enough time for an appreciable skin of metal to solidify against the surface of the mold, the mold is tilted and the still liquid metal is poured out. This leaves a hollow thin walled casting of irregular inside surface and irregular shell thickness.

Zinc alloys, lead alloys and certain aluminum alloys are used for slush castings.

Pouring molten metal into sand molds. For large castings molds are often constructed in pits in foundry floor. *General Motors Corporation*

CENTRIFUGAL CASTINGS

Any metal that can be cast in a sand mold can be cast in a centrifugal mold. Such molds are made of metal and mounted so that they can be rotated. While the mold is rotating, molten metal is poured in and distributed by centrifugal force around the wall of the mold. This method was first developed for the manufacture of pipe and later was applied to the production of gun barrels and other cylindrical shapes that can be rotated around their center of gravity axis. For irregular shapes the molds are placed radially around a central pouring cavity to which the molds are connected by sprues. The whole mass is rotated and the molten metal poured in at the hub. Centrifugal force drives the metal into the mold cavities where it solidifies under pressure. This process is known as centrifuge casting.

Costs. Because the metal molds cost considerably more than patterns, castings are made by this process only when relatively large quantities are required.

Size Limitations. There is no definite limitation to the size that can be cast centrifugally. About the largest pieces being produced at this time by this method are barrels for heavy guns. Many of the cylinder barrels for aircraft air-cooled engines are made by this process.

Design Features. Centrifugal pressure on the molten metal squeezes the metal that is heavier than the slag toward the outer periphery and the impurities such as slag inclusions and oxides are squeezed toward the center of rotation. If the slag is the heavier, the reverse is true. The resulting casting is therefore clean and has a denser grain structure than is obtainable in castings produced in stationary molds.

Assembling a mold used in the centrifugal casting of a tank sprocket wheel. Sprockets are poured as mold spins on horizontal plane. *Ford Motor Company*

PRECISION CASTINGS

Commonly called the "Lost wax method" the precision casting process was first used for jewelry and dental inlays. A mold is first made of metal, rubber or bonded graphite material. Wax or a volatile plastic is poured into the mold. When the wax has hardened, the mold is taken apart and the wax pattern taken out. The pattern is then "invested" in a ceramic body with suitable openings provided for subsequent operations. When the ceramic body has hardened it is fired, during which operation the volatile plastic pattern evaporates. This leaves a porcelain mold.

In casting, the porcelain mold is filled with molten metal. Generally pressure is applied to the molten metal by means of compressed air or by spinning the mold to create a centrifugal force.

Materials. Practically any metal or alloy can be precision cast, but the process finds its principal value in the casting of tungsten and tantalum carbides and high alloys that are difficult to machine.

Tooling Costs. These are relatively low.

Dimensional Accuracy. Exceptionally high dimensional accuracy is obtained in precision castings, it is the principal reason for the use of this casting method. With proper control, dimensions can be held to an accuracy of plus or minus 0.001 in. Fine details on the wax or plastic pattern are reproduced precisely on the surface of the casting. Threads can be cast, requiring little or no further machining. Wall sections can be cast exceptionally thin. Bosses, undercuts and irregular shaped holes can be made. Cast dimensions are so close that machining of castings is either eliminated or reduced to a minimum.

Size Limitations. At present most of the castings produced by this process weigh only a fraction of a pound although some castings weighing as much as 10 lb. have been made commercially. The industrial application of this process is new. Undoubtedly further developments will progress rapidly.

Design Features. Precision casting process is economical for the production of parts having an irregular and complicated shape. It is the only commercial process by which intricate accurately dimensioned parts can be made of materials difficult to cut, such as the tungsten carbides and some of the high alloy steels. It is of interest to note that the commercial production of gas turbines had to await the development of this technique before the blades and nozzles for such turbines could be produced economically.

DIE CASTINGS

Principal die casting materials are alloys of zinc, aluminum, magnesium and copper. A few die castings are made of lead base alloys and also tin base alloys but such die castings have an extremely limited commercial application.

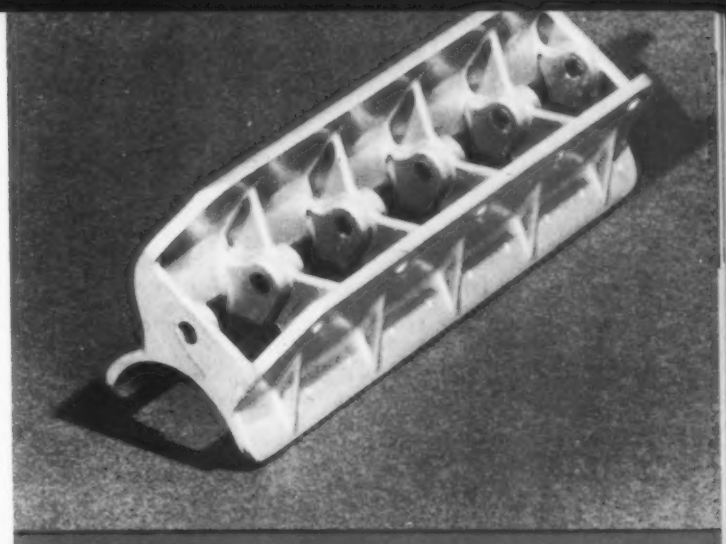
Tooling Costs for die castings are the highest of any casting process both with reference to the initial cost of the dies and cost of die maintenance and replacement. After the die has been made it is usually expensive to change the design of a part that is to be die cast.

Dimensional Accuracy. Dimensional accuracy of die castings is somewhat higher than that of precision castings. Because of the high dimensional accuracy, subsequent machining is usually not required and the parts can be assembled interchangeably.

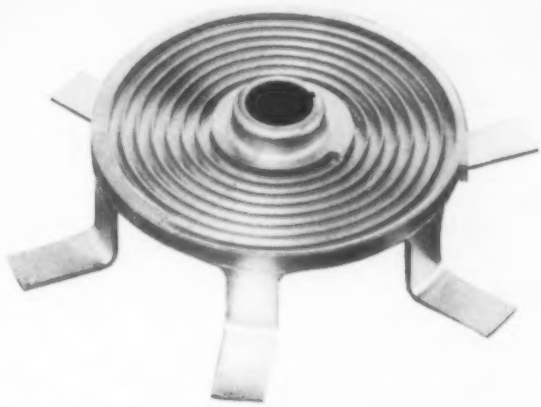
Size Limitations. Size of die castings range from the size of a zipper or talon fastener, to pieces weighing 10 lb. or more. There is no definite maximum size, the limiting factor being the size of the die casting machine available.

Design Features. Shape of die castings may range from simple solid pieces to intricately cored irregularly shaped parts such as carburetor bodies. Internal and external threads requiring no further machining can be die cast as can flats, slots, cross holes, irregular contours, keyways and bosses. Letters, numbers, trademarks, stippling, knurling can be produced on the part in the die casting operation.

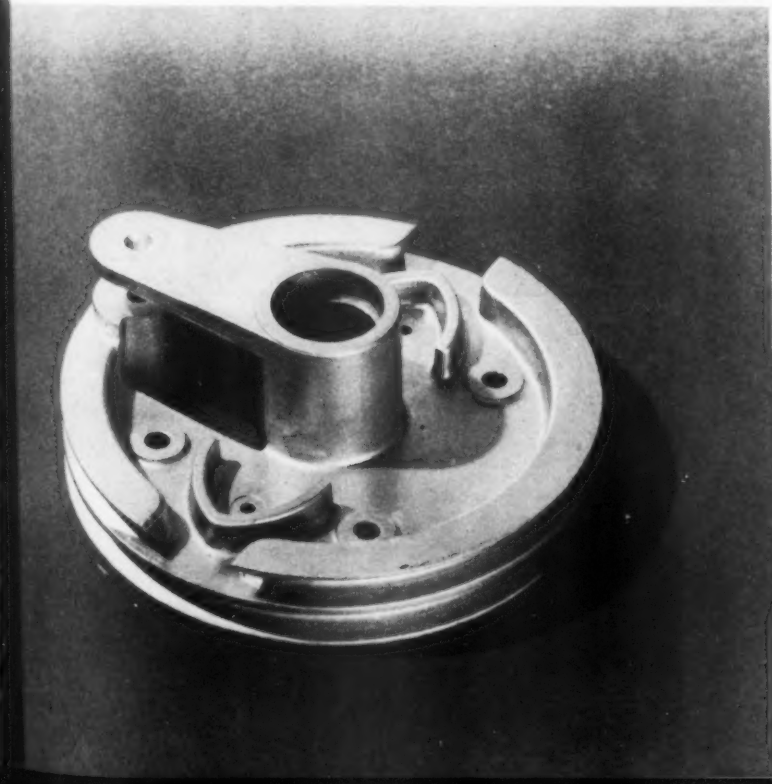
Inserts of metal or certain non-metallic materials having the required strength and temperature resist-



Multiple pulley bracket die cast of aluminum base alloy. Holes through six sections of the casting are held in alignment. Cores forming these holes are tapered, so that a final reaming operation is necessary to size the holes. *Harvill Corporation*



Trim indicator wheel die cast of aluminum base alloy. Uniform continuous spiral groove of 7/32 in. pitch and 5/32 in. deep is cast to size.

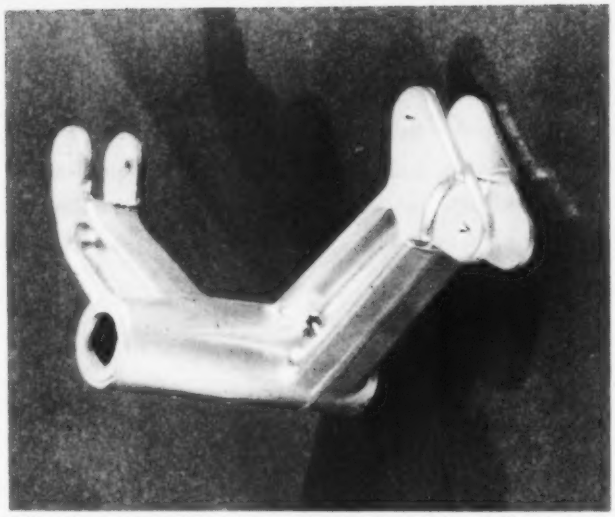


Cable control drum die cast of aluminum base alloy. Grooves are cast to size and held concentric with center hole. Arm and recess in body beneath arm are formed by interlocking cores. *Harvill Corporation*

ance can be placed into the die and the metal then die cast around the insert. As an example, sleeve type bearings of solid bronze, porous bronze or hardened steel are sometimes cast-in by this method.

Die castings can be assembled by riveting, gas welding, and electric welding.

FINISHES FOR DIE CASTINGS. Because of their extremely smooth surfaces it is often unnecessary to apply further surface finishing treatment. If appearance is a highly important consideration die castings can be buffed, polished, brushed or tumbled. Sprayed metallic finishes can be applied. Most of the die casting alloys can be electroplated. Chemical treatments are sometimes used for surface finishes but more often are applied as a base for enamel or lacquers. Organic finishes such as enamels or lacquers can be applied to all types of die castings. The die casting can be given a coating by repeated dipping in nitrocellulose or ethyl cellulose solutions or by spraying these solutions. Cellulose acetate or cellulose acetate butyrate plastics can be injection molded over die cast parts.



Bellcrank operating lever die cast in aluminum alloy. Drill points are provided in the ears at the end of both arms. *Harvill Corporation*

Metallic coatings can be applied by dipping in molten metal such as lead or by metal spraying.

The accompanying table sets forth the comparative physical properties and features of die castings made of the commonly used die casting alloys.

COMPARATIVE RATINGS FOR DIE CASTING ALLOYS

SELECTION FACTOR	ALUMINUM ALLOYS A.S.T.M. Nos. 5, 7	BRASS	MAGNESIUM ALLOYS A.S.T.M. Nos. 12, 13	ZINC ALLOYS A.S.T.M. Nos. 21, 23, 25
MECHANICAL PROPERTIES				
Tensile strength	3‡	1 (strongest)	4	2
Impact strength	3‡	1 (toughest)	4	2
Elongation	3‡	1 (most ductile)	4	2
Dimensional stability	1	1 (most stable)	1	4*
Resistance to cold flow	2	1 (most resistant)	2	4
PHYSICAL CONSTANTS				
Electrical conductivity	1 (highest)	2	3	2
Thermal conductivity	1 (highest)	2	4	3
Melting point	2	1 (highest)	2	3
Weight, per cu. in.	2	4	1 (lightest)	3
CASTING CHARACTERISTICS				
Ease, speed of casting	2	4	2	1 (easiest)
Maximum feasible size	1 (largest feasible)	2	1 (largest feasible)	1 (largest feasible)
Complexity of shape	1 (greatest feasible)	2	1 (greatest feasible)	1 (greatest feasible)
Dimensional accuracy	2	3	1	1 (most accurate)
Minimum section thickness	2	3	2	1 (thinnest)
Surface smoothness	2	3	1	1
COST				
Die cost※	2	3	2	1 (lowest)
Production cost	2	3	2	1 (lowest)
Finishing cost†	2	2	3	1 (lowest)
Cost per piece**	2	3	2	1 (lowest)

*Through the use of a low-temperature annealing treatment, alloy 23 can be made virtually stable in dimensions.

※Dies for casting the low melting point alloys are least expensive and have longest life.

†Includes polishing and buffing expense as well as ease of applying all types of commercial finishes, both electrodeposited and organic.

**Based on die, material, and fuel costs, production speed, and machining and finishing costs.

‡No. 218 Aluminum alloy and No. 360 Aluminum alloy, (now under investigation by American Society for Testing Materials) have tensile, impact strength and elongation in class 2, that is, equal to those of Zinc alloys.

FORMING METHODS

FORGINGS

Forging dies particularly those for drop forgings and hot pressed forgings are relatively expensive. Because of the high die costs involved, parts are not made as forgings unless a large quantity is to be produced.

DIMENSIONAL ACCURACY. Dimensions that are parallel to the plane of the parting line between the two halves of the die can be held to a high degree of accuracy, the accuracy being determined by the care with which allowances have been made for finishes. Dimensional lines that pass through the parting plane between the two halves of the die cannot be held to as high a degree of accuracy because of the variable thickness of the flash that is squeezed out from the forging and opens the two halves of the die. To obtain greatest accuracy, forgings are given a coining or swaging operation in which the part is pressed or hammered to a high degree of dimensional accuracy.

SIZE LIMITATIONS. Forged parts can be extremely small or quite large. There is no definite limitation on the size of hammer forgings, as illustrated by forged gun barrels. Drop forgings and hot pressed forgings are limited in size by the equipment available. About the largest size aluminum hot pressed forgings are the crankcase parts for aircraft engines.

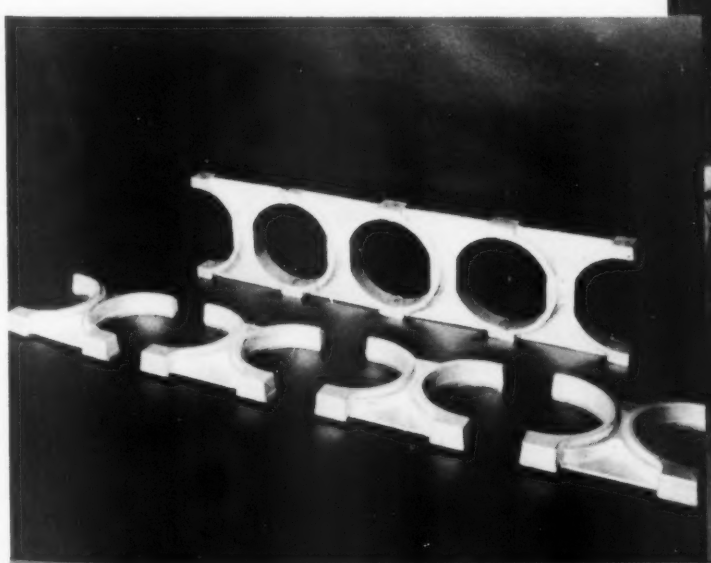
DESIGN FEATURES. The hot working of metal usually improves its grain structure and thereby its physical properties. Hence forged parts are generally stronger than the same part made as a casting.

Dimensional tolerances of forgings can usually be held within closer limits than sand castings and successive pieces are produced with smaller variations in a given dimension.

Although all metals oxidize to a greater or less extent when heated to the forging temperature, forgings have exceptionally smooth surfaces especially hot pressed forgings. All hot forgings have a surface scale which must be removed by blasting before machining.

COLD HEADING

Cold heading can be considered as a forging operation done at room temperature. It is the process used in the manufacture of rivets, bolts, tappet valves and similar products. Usually the parts are produced in an automatic cold heading machine at a rapid rate.



Drop forged sections and assembly which was formed by flash welding. *Lukenweld Incorporated*

Drop forging the end boss on a connecting rod under a steam hammer. *Ohio Forge Machine Company*

EXTRUSIONS AND COLD DRAWN SHAPES

In the extrusion process metal is heated to a plastic condition. By means of a plunger, pressure is applied to the metal which is then forced out through a die opening thereby producing bars of any desired cross-section or tubes of a given desired cross-section. Usually the cross-section is constant throughout the length of the bar or tube.

Cold drawn sections are produced by pulling cold bars through successive dies thereby producing bars of regular or irregular cross-section. Tubes are drawn cold in a somewhat similar manner to produce seamless tubes of highly accurate diameter.

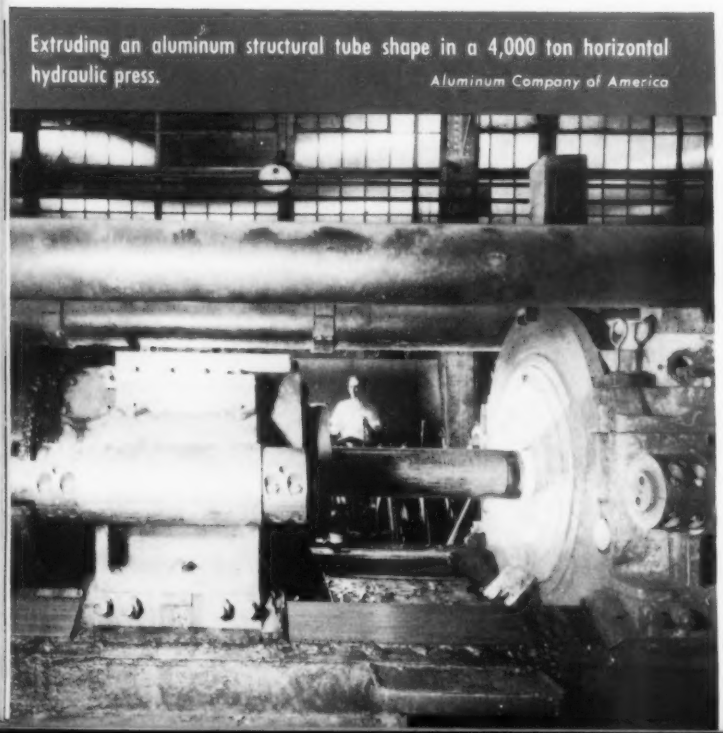
TOOLING COSTS are relatively low both for extrusions and cold drawn sections, the only cost involved being that of the die.

DIMENSIONAL ACCURACY. Both extrusions and cold drawn sections have dimensional accuracy of the order of thousandths of inches varying with the size of the section and the material.

SIZE LIMITATIONS. There are no definite limitations on the maximum size of extruded tubes and sections, the limits being determined by the size of equipment available and the pressure required for extrusion. Maximum sizes will vary according to the plasticity of the metal at the extrusion temperature.

DESIGN FEATURES. Initially, extruded sections and cold drawn sections were used primarily to save machining expense. By proper design it is often possible to make parts from extruded or cold drawn stock which require very little machining other than cutting a piece to length.

Extruded and cold drawn parts also have the advantage of smooth surface finish. Cold drawing of steel parts produces a hard skin which is often desirable.



Extruding an aluminum structural tube shape in a 4,000 ton horizontal hydraulic press. *Aluminum Company of America*

Tank shell fabricated of components by welding. Main component is an impact extruded aluminum shell. Bosses on bottom are die formed in impact extrusion operation. *Lewyt Corporation, and Sperry Gyroscope Company*

IMPACT EXTRUSIONS

In impact extrusion, a cold or moderately heated disk or slug of metal is placed in a shallow cup shaped die in a power press. A punch, the diameter of which is less than that of the die, then strikes the slug forcing the ductile metal of the slug to flow through the annular clearance between the punch and the die and upward around the punch. Tin, lead, pure aluminum and certain alloys can be extruded commercially.

TOOLING COSTS for impact extrusions are relatively low.

DIMENSIONAL ACCURACY. Cross-sectional dimensions of impact extrusions are in the order of thousandths of an inch and are higher than that of stampings.

SIZE LIMITATIONS. Maximum size of parts produced depends upon the capacity of equipment available. Pieces as large as 6 in. in diameter with about ¼ in. wall and relatively heavy bottoms have been produced.

DESIGN FEATURES. Cross-section of an impact extruded part may be circular, oval, rectangular or of irregular shape. The outer and inner surface of the cylindrical portion may be plain or corrugated or ribbed. The walls of the impact extrusion may be extremely thin, as in toothpaste tubes, or as thick as approximately ¼ in. The thickness of the bottom bears no relationship to the thickness of the wall. The bottom may have bosses or lugs integral with it on the inside or outside.

Outstanding advantage of impact extrusions is that they are produced in one operation, thus a square can which may be expensive to produce as a stamping can be produced as an impact extrusion in one blow.

PRESSED POWDERED METAL PARTS

Pressed powdered metal parts are produced on a press by placing a measured quantity of finely powdered metal in a die cavity and then squeezing this powder by pushing a plunger into the die cavity to form a compact mass which is then heat-treated in a furnace. Depending on the technique employed the finished part may be a solid material or of varying degrees of porosity.

TOOLING COSTS for powdered metal pressings are moderate as the parts are produced in one pressing operation.

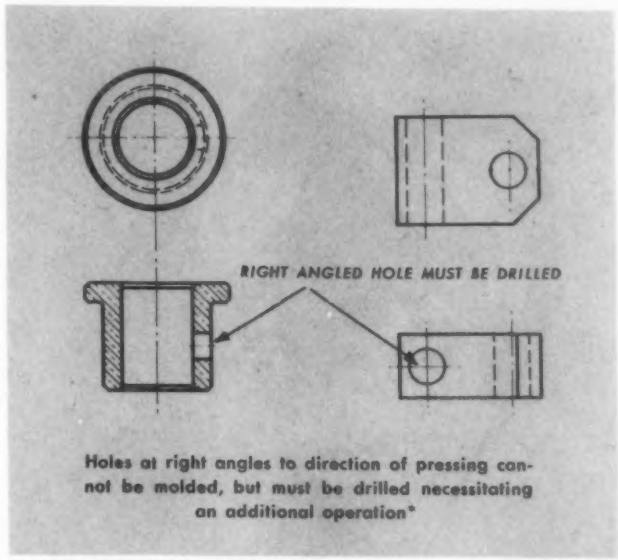
DIMENSIONAL ACCURACY. Dimensions perpendicular to the direction of travel of a plunger can be held to a fraction of a thousandth of an inch. Dimensions parallel to the direction of travel of the plunger may vary several thousandths.

SIZE LIMITATIONS. There are no definite limitations on the size of pieces that can be produced as powdered metal pressings other than the capacity of the equipment available. Parts having a superficial area as much as 10 sq. in. have been produced.

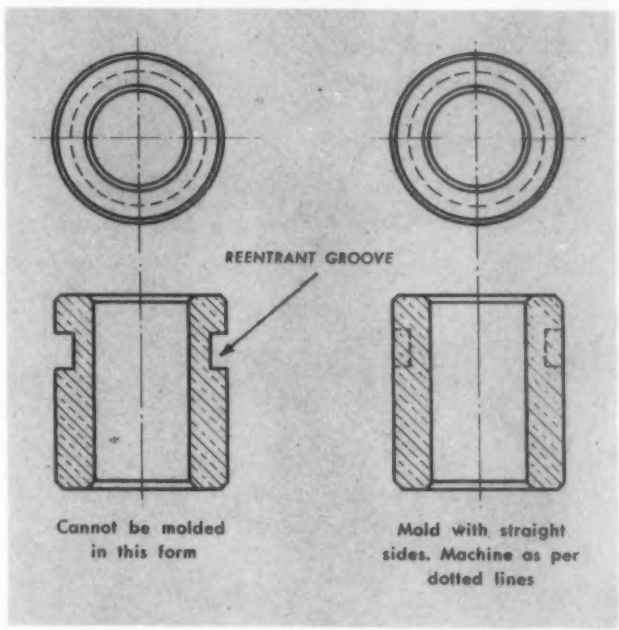
DESIGN FEATURES. It is essential that the shape of powdered metal pressings be such that all of the particles of powder will be subjected to the direct pressure exerted by the plunger. Hence such pressings cannot be made with undercuts perpendicular to the axis of the part.

Parts that are complicated in shape and that would require relatively expensive machining to finish to the desired dimensions can often be made more economically as powdered metal pressings. The maximum tensile strength of a powdered metal pressing may be as high as 80 percent of the tensile strength of the solid material. Porous pressings such as used for oilless bearings and filters are, of course, relatively weaker. Porosity of the finished parts can be controlled.

Two or more metal powders can be mixed to produce a material which retains proportionally the individual characteristics of each constituent.

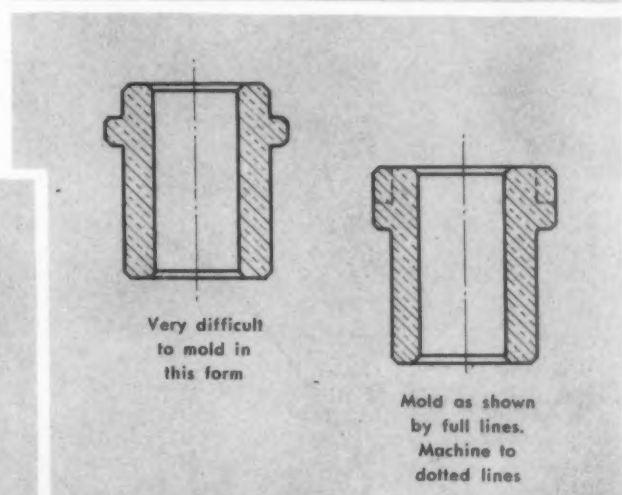


Holes at right angles to direction of pressing cannot be molded, but must be drilled necessitating an additional operation*



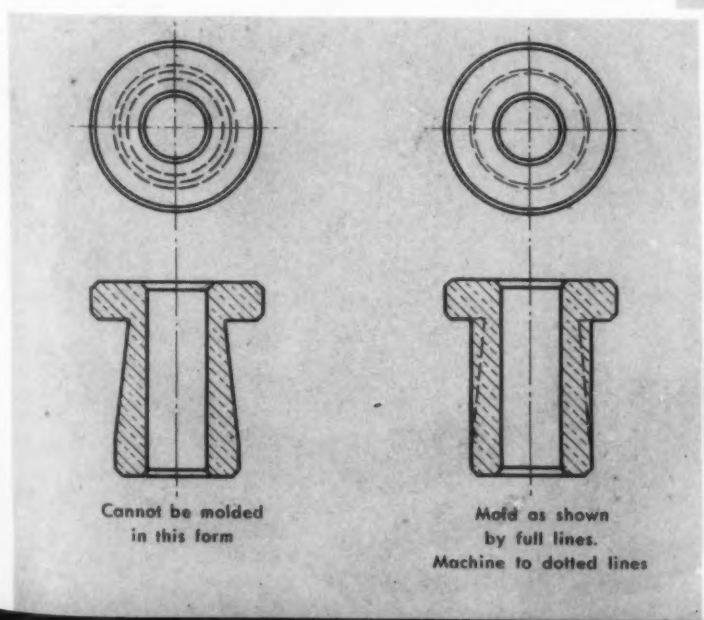
Cannot be molded in this form

Mold with straight sides. Machine as per dotted lines



Very difficult to mold in this form

Mold as shown by full lines. Machine to dotted lines



Cannot be molded in this form

Mold as shown by full lines. Machine to dotted lines

Design of powdered metal parts. Keystone Carbon Company

STAMPINGS AND DRAWN PARTS

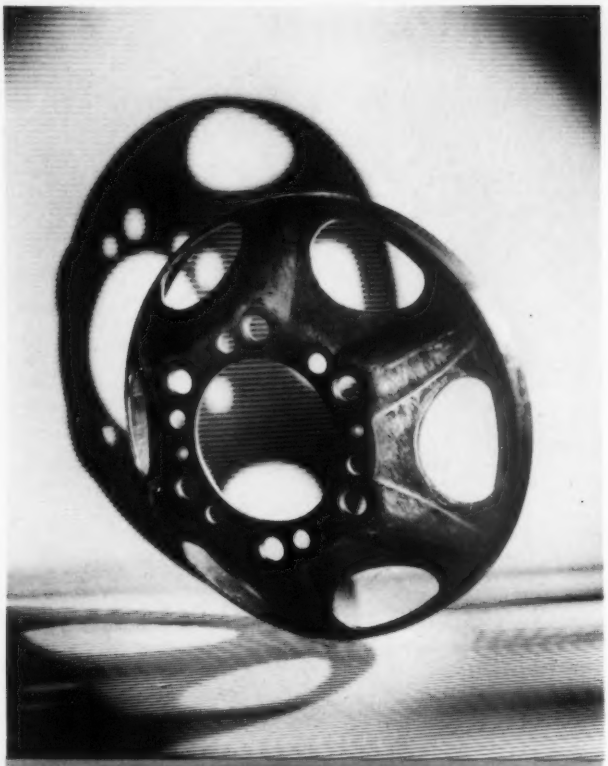
Stampings can be made of steel, copper, brass and aluminum.

Tooling Costs. Depending upon the size and proportions of the part, tooling costs may be high or low. Usually parts are made as stampings only when large quantities are required although many simple stampings can be produced economically in small lots.

Dimensional Accuracy. Commercial tolerances on stamped and drawn parts are of the order of a few thousandths of an inch. When an especially high degree of accuracy is required, it is obtained by coining operations in which the part is swaged and squeezed to its final dimensions to an accuracy of the order of a thousandth of an inch or less.

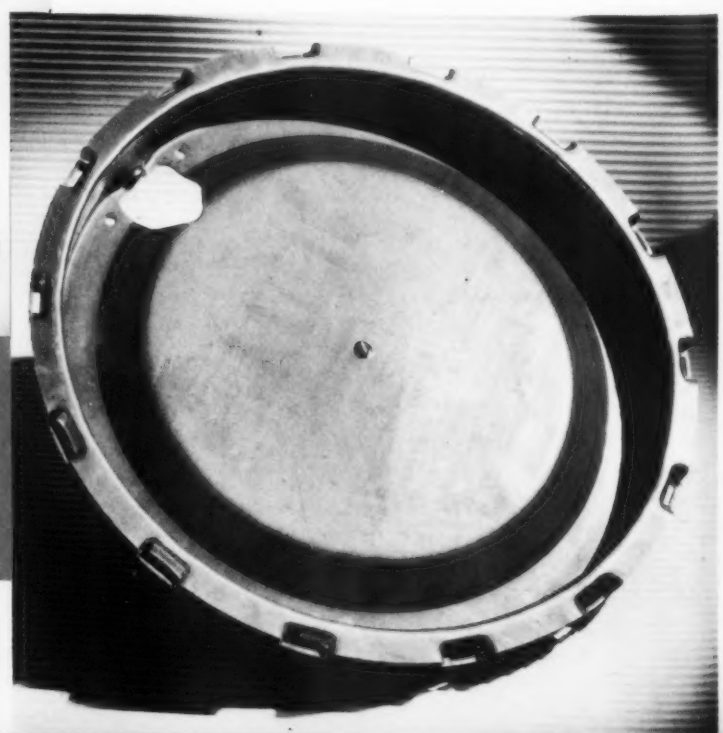
Size Limitations. There are no definite limitations on the design of parts to be made as stampings. If the size of the part is too great for the press capacity available it can be made in two pieces and then flash welded together as in the method used in the manufacture of automobile bodies.

Design Features. Metal stampings produced in large quantities are in general low in cost and accurate in dimensions. Parts may range in shape from flat plates of regular or irregular shape having a variety of holes to deep drawn vessels with stiffening ribs and embossings. For maximum economy, round shapes and circular holes are cheapest to produce. Square and irregular cross-sections should be avoided. Corners should be well rounded with the radii at least equal to the thickness of the sheet. Curled edges and corrugated areas can be incorporated in parts of thin materials to add stiffness.



Spider for wheel blanked, drawn and formed from sheet steel.

Steel parts made by blanking, punching, drawing and forming operations. *Worcester Pressed Steel Company*



Shallow drawn disk shaped stamping with punched holes in formed pockets around flange.

FLAME CUTTING

Ferrous materials can be cut in profile with an acetylene flame, the torch being guided by hand or by a pantograph. For mass production machines are automatic.

TOOLING COSTS. Other than the costs of templates or patterns there are no tooling costs.

DIMENSIONAL ACCURACY of flame cut parts will vary with the thickness of metal being cut, and will range from about $\frac{1}{32}$ in. to possibly as much as $\frac{1}{8}$ inch.

LIMITATIONS. Plates up to 12 in. thick can be flame cut.

DESIGN FEATURES. Flame cutting makes possible the profiling of sheets, plates, billets and forgings to shapes that are difficult or too large to be machined. If a number of pieces of same size and shape are to be cut from thin sheets, the sheets are often piled and cut in one operation.

Applications for flame cutting include the beveling and grooving of plates preparatory to welding, profiling of large sheets and forgings, cutting of access and lightening holes in sheets and similar operations.

FLAME HARDENING

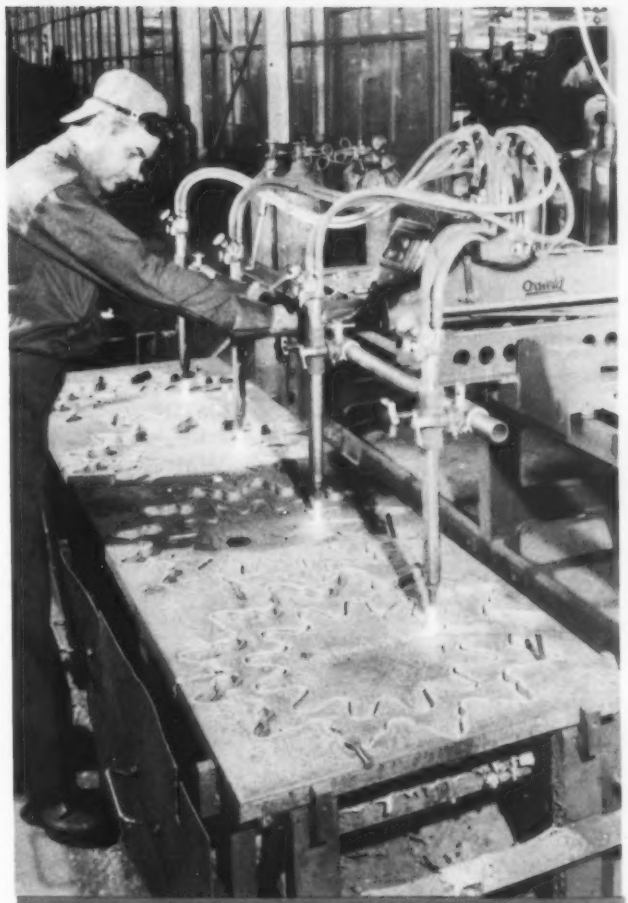
Hardening with acetylene flame consists of heating the surfaces of metal parts to a temperature higher than the critical and then quenching with water or compressed air. By subsequent reheating the hardness can be tempered as desired.

TOOLING COSTS. None, except possibly special torch tips to suit contoured work.

DESIGN FEATURES. Flame hardening is used for hardening a restricted area on large parts made of materials that are hardenable by heat-treatments such as steels of 0.35 percent carbon or higher.

Depth of hardness is governed by the depth to which the metal is heated to a temperature above the critical. This is controlled by adjusting the speed of travel of the torch and the volume of the flame. The degree of hardness obtained depends upon the hardenability factor of the steel and the rate of quenching.

The operation may be performed entirely manually by manipulating the torch back and forth across the surface to be hardened and after obtaining the desired temperature quenching the surface with oil, water or compressed air. For quantity production such as in the hardening of gear teeth, the part can be mounted on a lathe and rotated at a pre-determined speed. The oxyacetylene torch is mounted so that the flame will impinge on the work as desired. After passing through the flame, the metal is quenched in a stream of oil or water.



Flame cutting four sprocket wheels simultaneously. Path of multiple torch head reproduces contour of a template.

Flame hardening teeth on spur gear with oxyacetylene flame.

WELDING

Types of welding are gas welding, arc welding and resistance welding. Complicated forgings and castings can be welded together from simple components. Intricate stamped and drawn shapes can be designed to be made as a welded assembly of simple elements.

GAS WELDING. Conventional gas welding is done with an oxyacetylene flame. It is generally used to join thin sheets which are usually flanged prior to assembly, the upstanding flanges furnishing the filler metal for the welding operation. Inherently it is a more expensive type of welding than arc welding, but is generally more suitable than arc welding for the welding of thin sheets. Practically all metals can be welded with an oxyacetylene flame.

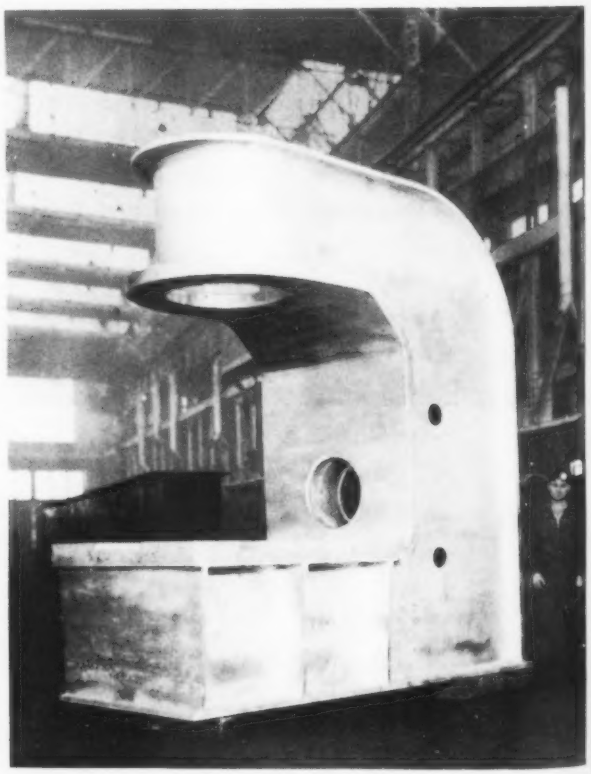
ARC WELDING. In arc welding an electric current furnishes the heat to fuse the metal to be welded. The electrodes may be carbon or metal. In carbon arc welding extra metal is added by feeding a metallic rod into the flame. When a metal electrode is used the welding rod is the electrode.

Arc welding may be done by hand or by an automatic machine.

Electric arc welding is inherently more economical than gas welding and hence more widely used. Usually, if the weld is to be subjected to high stresses it must be peened or annealed in the furnace to relieve internal stresses. The latter method is usually the better as it completely stress relieves the welded structure.

RESISTANCE WELDING. Resistance welding is done on a machine in which the parts to be welded together are squeezed between two electrodes at the point to be welded and a pre-determined amount of current is passed through. The resistance at the surface to be welded causes the generation of heat which fuses the metal. In spot welding the action occurs over a small circular area from ⅛ to ⅞ in. in diameter. Lapped metal sheets are frequently joined by spot welding.

Seam welding a cylindrical metal jacket in which an electronic tube mechanism is inclosed. *Westinghouse Electric & Manufacturing Company*



Housing for a 255 ton joggling press, welded together from steel slabs and plate. Housing weighs 16 tons. *Lukenweld, Incorporated*

BRAZING ALLOYS are of three types: Copper, silver alloys, and aluminum alloys.

Copper brazing, because of the high temperature required to melt copper, is used only with ferrous materials and the cupro-nickels Many carbon and alloy steels can be brazed with only a suitable reducing atmosphere for a flux. Steels containing considerable chromium, silicon, aluminum or manganese require protection against oxidation.

Silver brazing is used for non-ferrous materials and stainless steel.

Aluminum base alloy filler material is used in brazing aluminum parts. 2S and 3S wrought non-heat-treatable aluminum can be brazed and will be fully annealed in the operation. Heat treatment of 53S and 61S heat-treatable aluminum alloys can sometimes be combined with the brazing operation.

TOOLING COSTS are low for large quantity production. Tool cost is limited to that required for jigs and fixtures necessary for holding the parts in alignment during brazing operation. Special inductor coils may be required if heating is done by induction methods.

SIZE LIMITATIONS. Practically no limitation on size of parts when joined by torch methods or induction heating methods. In furnace brazing, the size of furnace determines the maximum size of part.

DESIGN FEATURES. Adjoining edges or surfaces of parts that are to be joined by brazing must be fitted closely together, metal to metal contact is desired. In copper brazing, the parts are assembled and held together by pressing, swaging, crimping, riveting, pinning or spot welding to prevent slippage of the parts while the copper brazing material is in a liquid state.

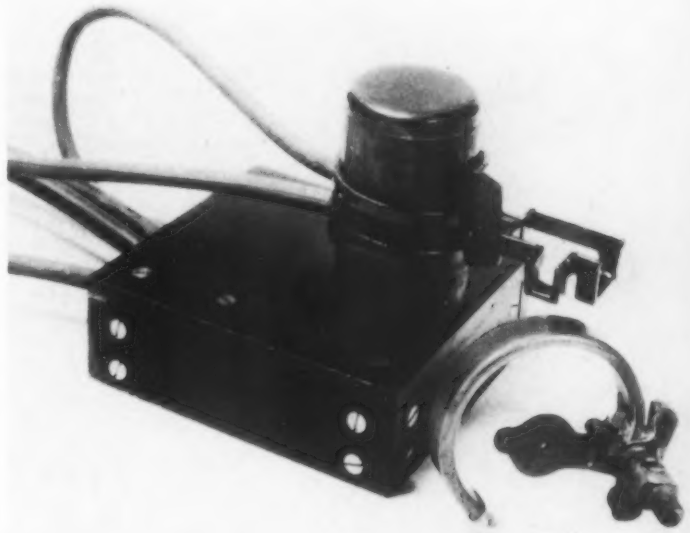
Strength of brazed joints depend upon the design, area and thickness of the joint, the composition of metals joined and the brazing alloy. Cross-sectional area of members or parts to be joined should be approximately equal at the joint.

Number of joints that can be brazed simultaneously in a furnace is limited only by the ability to hold the parts in place during brazing.

Products that are difficult to make in one piece can be made in sections in the form of punchings, drawn shapes and screw machine parts, then assembled by brazing.

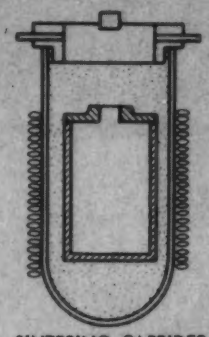
Heat-treatments can be carried on either during or following furnace brazing operations. As delivered from the furnace the work is normally bright and clean, requiring no further finishing.

BRAZED ASSEMBLIES

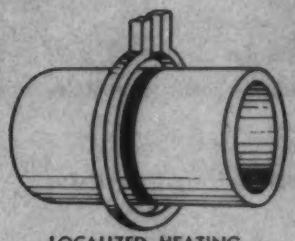


Induction heating arrangement for brazing bourdon gage tubes to pressure connection fitting. *Ajax Electrothermic Corporation*

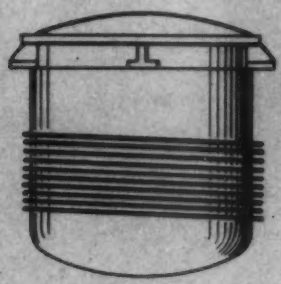
Subassemblies copper brazed in box type controlled atmosphere furnace. *General Electric Company*



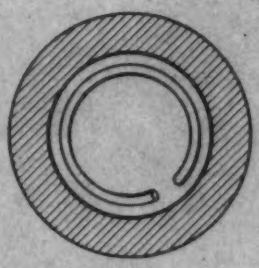
SINTERING CARBIDES



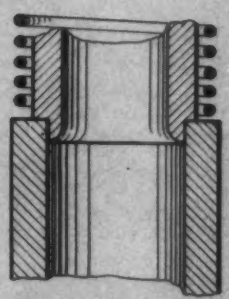
LOCALIZED HEATING



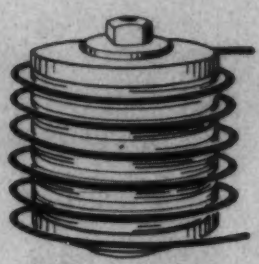
HEATING AUTOCLAVES



INTERNAL HEATING



HEATING SHRINK HEADS TO REDUCE PIPING

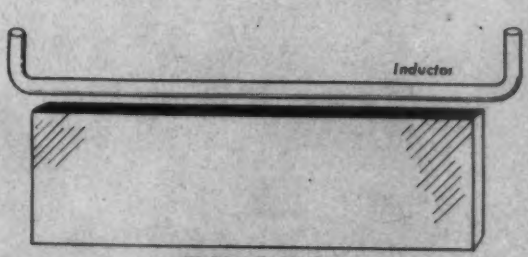


SETTING PLASTIC TO BOND ROTOR LAMINATIONS

DEGASSING VACUUM TUBES

SHRINK FITS

DIE HEATING



EDGE HEATING

Typical industrial applications of induction heating.
Ajax Electrothermic Corporation

INDUCTION HEATING

Induction heating is the generation of heat in any material capable of conducting an electric current, by placing the material in a magnetic field of a coil carrying a high frequency alternating current. Non-magnetic materials such as carbon, aluminum, copper, and non-magnetic steels respond readily to induction heating.

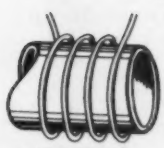
TOOLING COSTS are limited to expense for inductor coils, quenching rings, and fixtures for holding work.

SIZE LIMITATIONS. Applications are limited only by the difficulty or impossibility of forming a heating coil or inductor that will properly fit the surface of the part requiring heat, or the lack of a low frequency generator having sufficient output power to heat adequately the surfaces.

DESIGN FEATURES. Heat generation is confined to regions lying in the magnetic field. The process makes possible the production of locally hardened steel parts such as gears and cams, with a desired degree and depth of hardness, metallurgical structure of core, demarcation zone and hardened case, with practically no distortion and scale formation. Both heating and quenching cycles can be entirely automatic.

Induction heating applications include: Soldering; brazing; heating metals preparatory to forging, upsetting, extruding and spinning; heating parts which are entirely surrounded by a glass envelope; melting metals in a controlled atmosphere or in a vacuum; and hardening bearing surfaces on machined parts.

CONTINUOUS PRODUCTION OF SPIRALLY BRAZED TUBING



ANNEALING WELDED STEEL PIPE

HEATING SHAPES FOR BENDING

DRYING WELDING ROD COATINGS

DIELECTRIC HEATING

Practically all non-metallic materials can be heated in a high frequency electrostatic field, they include: Cellulose, paper, textiles, powders, felts, leather, wools, cottons, ceramic clays, tobacco, rubber, celluloid, glass, fiber glass, and granulated cork.

TOOLING COSTS are low. Only flat sheet electrodes are required, except for parts having curved contours which can be shaped in wooden die blocks sprayed with metal to form electrodes.

SIZE LIMITATIONS. When pressure is required to process the work, size is limited only by size of press available. For work that does not require pressure there is no limit on size.

DESIGN FEATURES. Wood, leather, felt and paper can be formed into laminated structures by coating or impregnating the material with a bonding substance such as resin or glue, and then placing sheet electrodes and material between press platens. The resulting structures are dense, well-bonded, and stronger than the original material.

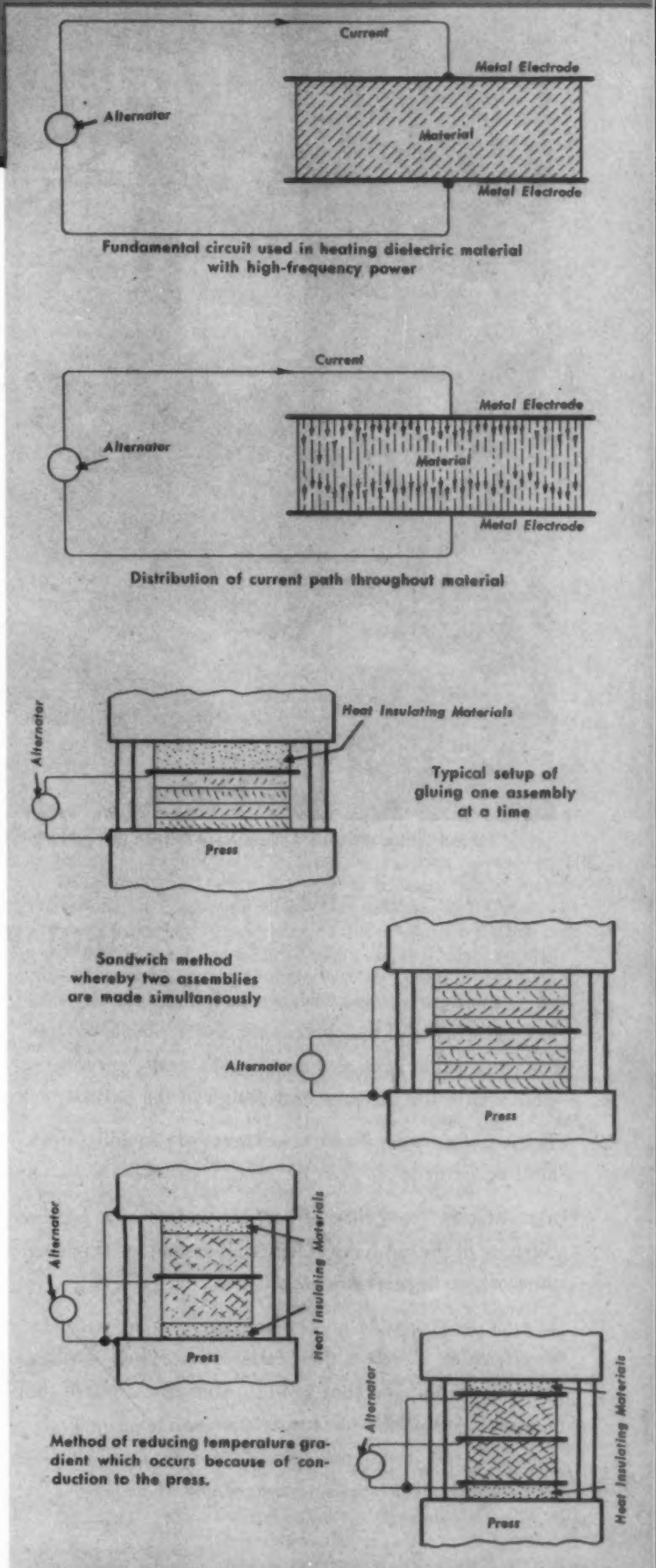
Cork granules mixed with urea or phenol resin are pressed and heated by this process to form cork boards of excellent strength, heat resistance, and heat insulation.

Dielectric heating is not limited to bonding and molding parts such as boards and slabs having plane surfaces. Parts having curved surfaces can be made if the section is approximately of uniform thickness. Constructions made by this process include propellers and keels for boats.

Process is used to produce heat to bring about chemical reactions, and to sterilize cereals and other foods.

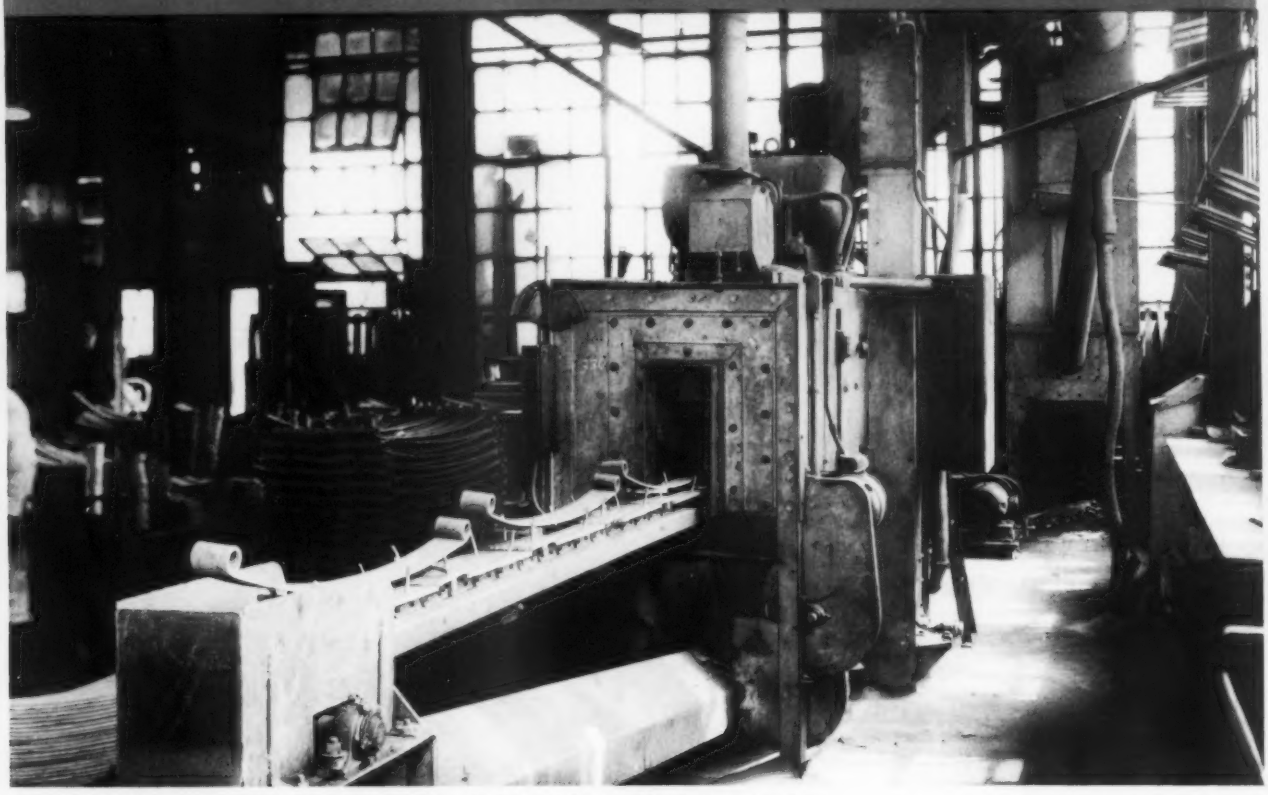
Advantages of dielectric heating include:

1. Increases speed of processing and reduces labor and equipment costs.
2. Produces and confines heat in the part at the zone where needed, thus reducing overall power consumption.
3. Is clean and does not require excessive floor space.
4. Improves the production qualities of a product.
5. Is flexible in its application to a variety of operations, processes or products.



Arrangements for heating dielectric materials with high frequency power.

SURFACE TREATMENTS



Steel leaf springs are carried on conveyor through shot peening machine for pre-stressing. *American Foundry Equipment Company*

SHOT PEENING

Shot peening has generally been applied to steel parts, but the benefits of the process are also applicable to cast iron, malleable iron and non-ferrous parts, varying in degree with the material and design of the parts.

TOOLING COSTS are limited to expense of providing work holding fixtures.

SIZE LIMITATIONS. Size of parts is limited only by the capacity of the mechanical handling system for exposing the work to the blast stream.

DESIGN FEATURES. Pre-stressing surfaces of parts by shot peening increases their fatigue life. When working stresses are applied that would ordinarily increase the tension stress on the surface, that tension is offset by the residual stress in shot peened surface layer. Compressive stress imparted increases with hardness of surface.

Factors that affect quality of shot peened parts include: Duration of exposure, size and hardness of the shot, velocity of shot, coverage and direction of shot, and hardness and physical properties of the work surface.

Care must be exercised so that damage to sharp edges of extremely hard parts by high intensity peening will not take place, otherwise spalling or chipping might result.

Shot peening will in general lengthen the fatigue life of any part that is subject to bending or twisting stress, but it has little effect on axial push-pull stress.

Applications for shot peening include: Leaf, helical and valve springs; gear teeth; splines; universal joints; steering knuckles; connecting rods; axles and shafts; torsion bars; and crankshafts.

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Design of Hydraulic Systems

IV—Selector and Relief Valves

HOWARD FIELD, JR.
Consultant

Selector and relief valves are analyzed as to their design, characteristics, uses and construction. Valves are classified as to type and sketches are used to illustrate the design and operating features. The problems of materials used and internal leakage are discussed in detail.

MODERN hydraulic systems require a device to direct and seal fluid pressure performing operations, control the speeds of operations and to relieve unwanted pressures. These functions are all performed by valves of various types each of which has many variants, each having characteristics which particularly adapt it to specific uses.

Selector Valves

Selector valves, as the name implies, select the particular mechanism to be operated as well as control its direction and speed of movement. Valves used as selector valves are: plug cocks, rotary disk valves, slide valves and poppet valves.

The plug cock and rotary disk valve are simple, rugged and, in the past, were often used as selector valves in spite of the serious disadvantage of requiring enormous handle loads for operation. For hydraulic work these valves are dependent upon the hydraulic fluid for lubrication as most lubricants are soluble in hydraulic fluids.

Plug cocks consist of a tapered plug, which must be seated in a conical bore by more pressure per unit area of engagement than the pressure they are intended to seal. This large area of contact makes the total force and resultant friction large, thus operation is difficult. Springs are often used to seat the plugs with the result that the plug becomes excessively tight, when not in use, and sometimes operation is nearly impossible.

Rotary disk valves were made in an effort to overcome the wedging action of the plug cock, and although this was accomplished the friction force remained large. The disk and its seats must be nearly optically flat to prevent leakage. This involves large contact areas which entail large frictions.

The Saval Company, in a patented construction, have reduced handle load and solved the problem of sealing rotary disk valves without leakage. In these valves any part which has high pressure applied to it is equipped, as shown in Fig. 1, with a "shear seal." When there is low-pressure in the passage the "shear seal" is held to the disk by a Marcel spring, and when under high-pressure is held to the disk with a force proportional to the pressure. Since the contact area is small the total force and consequent friction are small.

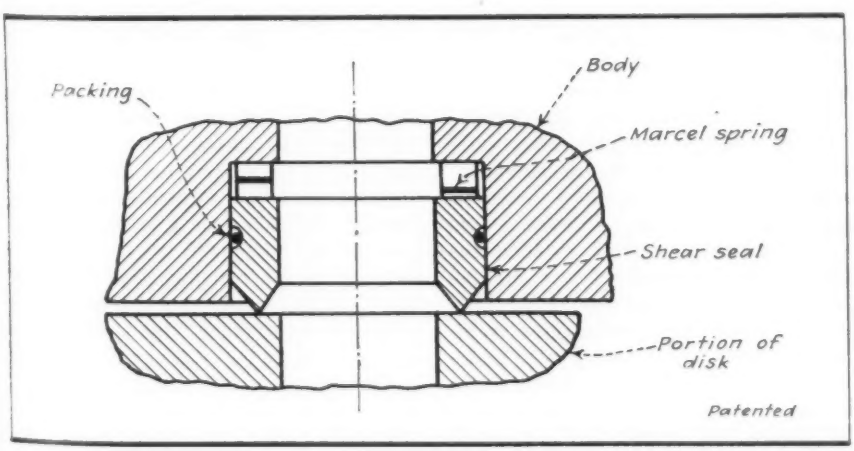


Fig. 1—A "shear seal" consists of a sealing ring which is held tight to the disk by a Marcel spring, at low pressures, and by fluid pressure on the top of the seal when high pressure is used. This device is used in rotary disk and in slide valves having no leakage.

Slide valves are frequently used as selector valves since little effort is required for their operation. Basically a slide valve consists of a housing in which there is fitted a slide or plunger. The housing must be equipped with a pressure port, two control ports and a return port. The slide or plunger can have two or more lobes properly placed to control the flow of fluid between the ports. Slide valves are classified as to the arrangement of the slide or plunger lobes in relation to the ports when the slide or plunger is in center or neutral position, and are as follows: (1) Closed-center type where all ports are closed. (2) Closed pressure open center type where the controlled mechanism is free to move in either direction but positive action in either direction is obtained. (3) Open center type where control ports and pressure are connected to the return. (4) Cylinder closed open center type where control ports are closed and pressure is connected to the return. Slide valves are also classified as balanced and unbalanced.

Most slide valves are of the lapped fit design and the problems inherent in that type construction must be carefully considered or the valves cannot perform in a satisfactory manner. One of the first of such problems is the choice of size for the plunger lobes. If their diameter is small the valve will have less internal leakage both because the fits can be made tighter and because the circumference of the lobe and consequent area of clearance path is small. On the other hand the pressure loss in the fluid flowing through the valve will be high and the parts may not be rugged enough to withstand normal abuse. In general it will be found that the best compromise is reached when the diameter is the larger of two factors: (1) Minimum diameter which will be suffi-

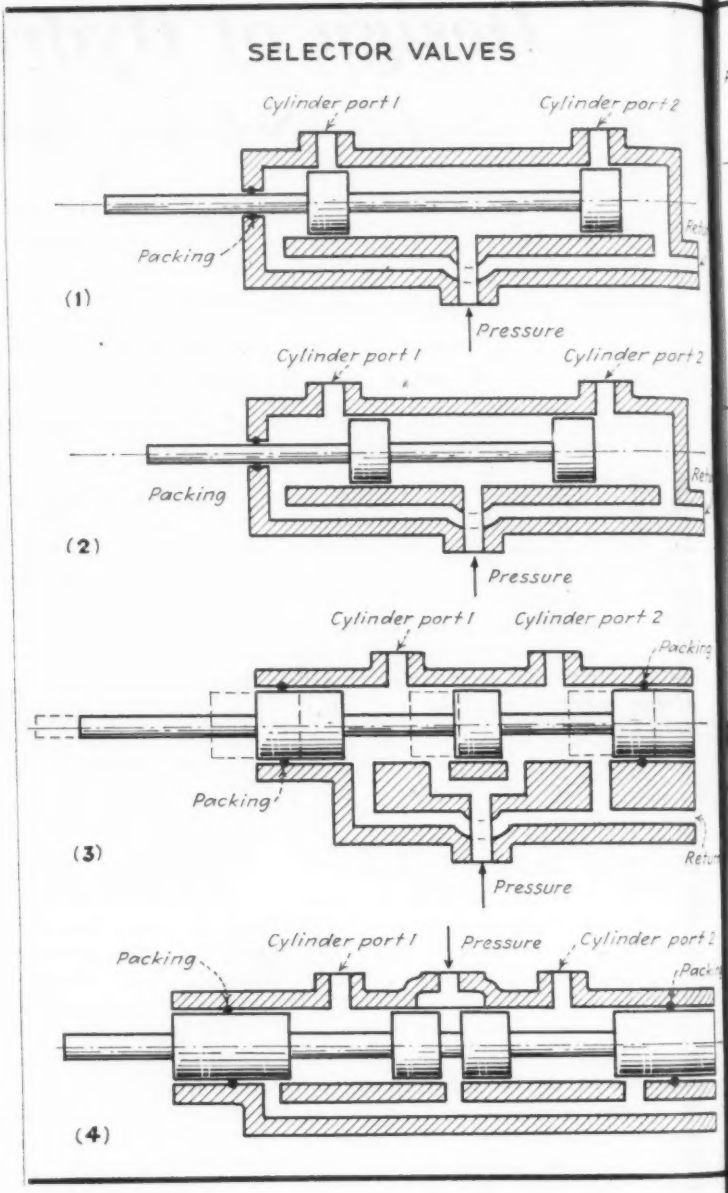
(1) Simple slide valve of the closed center type is shown in the neutral position. The lobes of the slide or plunger cover the two cylinder ports and no fluid can flow to or from either end of the cylinder and thus there can be no motion of the cylinder piston. Fluid pressure is isolated between the two lobes of the plunger. Movement of the plunger to the left would allow fluid pressure at cylinder port 1 and return to cylinder port 2 thus directing a corresponding movement of the cylinder piston. Movement of the plunger to the right reverses this action.

(2) A valve of the closed pressure open center type is shown in the neutral position. The cylinder piston is free to move in either direction since the cylinder ports are open to the return and fluid pressure is isolated between the plunger lobes. Motion of the plunger to the right or left gives positive action of the cylinder piston.

(3) A valve of the open center type is shown in the neutral position. The plunger has three lobes so arranged that cylinder ports, return, and pressure, are all interconnected. If the plunger were moved to the left, to the position shown by the dotted lines, cylinder port 1 would connect to the return and cylinder port 2 to the pressure.

(4) Another slide valve is the cylinder closed open center type. Shown in the neutral position the plunger has four lobes and pressure is connected to the return while cylinder ports are isolated allowing no movement of the cylinder plunger.

Note: The valves shown in (1) and (2) are unbalanced on the return side. In some cases this unbalance is useful but in the majority of cases it is undesirable. The valves shown in (3) and (4) are in complete hydraulic balance. Slide valves of all types may be made balanced, or unbalanced with respect to pressure at any port, by proper arrangement of porting and lobes.



ciently rugged. (2) Diameter to give the highest economical pressure loss.

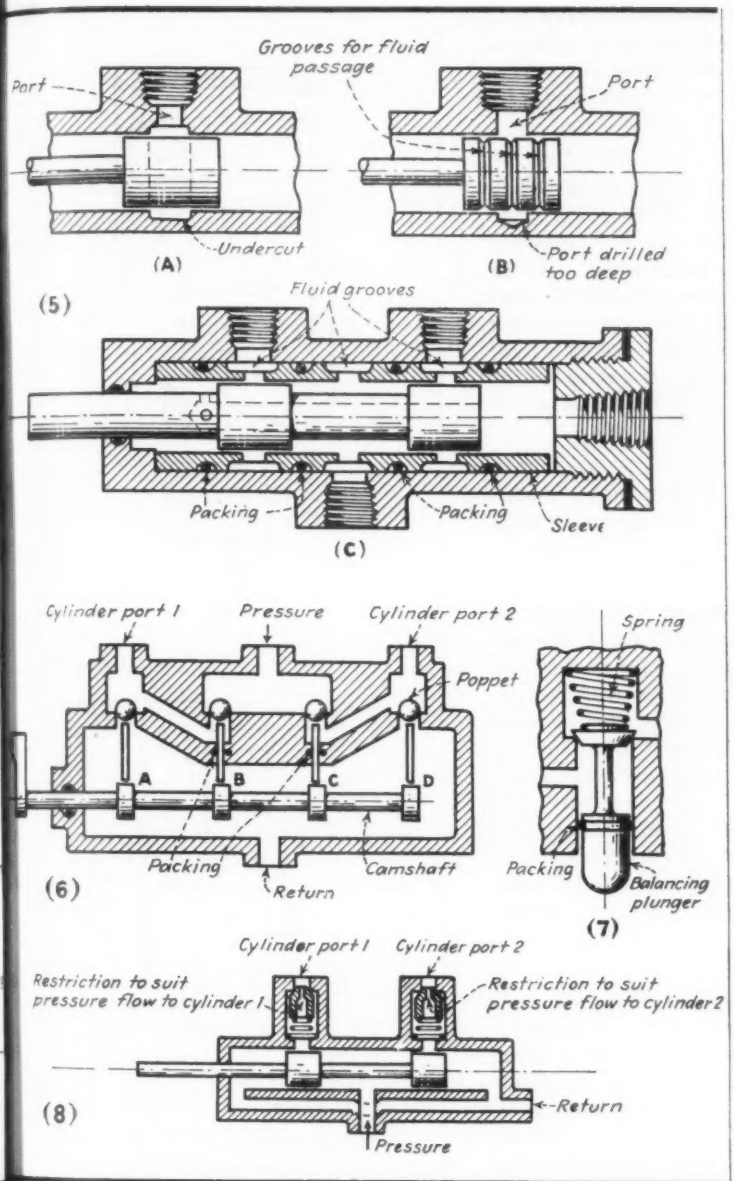
Another important consideration is the materials from which the plunger and its immediate surroundings are made. For aircraft work weight must be considered. Needless to say, the plunger and housing or sleeve in which it slides must be of materials which run well together although there will be no bearing pressure between them if the arrangement is correct. The materials must have thermal coefficients of expansion so related that the plunger will not bind at any temperature within the operating range of the equipment nor be too loose within this range. Slightly greater clearances can be tolerated at the colder temperatures since the fluid will have less tendency to leak when cold. The materials must be hard enough to withstand abrasion.

The detail design of the valve and its parts is of great importance. Since the clearances must be small it will not prove feasible to manufacture a valve having a two diameter bore in which a single, shouldered plunger must fit both diameters because of the serious difficulty in obtaining the requisite degree of concentricity between the diameters.

Many designs of slide valves have given trouble because the mounting arrangements were so designed that overtightening the mounting bolts would cause sufficient deflection to bind the plunger. Even more give trouble because the connections to the tubing spring the housing. One way of avoiding these deflection troubles is to make the plunger slide in a sleeve which can float a few thousandths of an inch in the housing. Of course the sleeve will need to be sealed, with respect to the housing, to prevent interflow between ports.

It might appear as if leakage could be reduced simply by making any port, over which the plunger slides, only on one side of the housing, thus having the smallest port area. This does not work in practice because the plunger is forced to the far side of the bore leaving the entire clearance at the port. More fluid will run through this crescent shaped opening than through a ring shaped opening of the same area. A secondary undesirable result is the high resistance, caused by this crowding action, to movement of the plunger. It is better practice to have any port divided into two ports opposite each other thus balancing the forces on the plunger. One way of doing this is to make an undercut at the port.

Unfortunately this method is not easily accomplished on automatic machines and particularly so if the undercut is far from the end of a small bore. Another way to accomplish the same result is to drill the port too deep and machine passages for fluid on the outer diameter of the plunger lobes. Sometimes the



(5) Side load on the plunger and resulting leakage, caused by a single drilled port, can be eliminated by an undercut (A) or drilling the port too deep and machining grooves on the plunger's outer diameter (B). If a sleeve is used (C) in the valve assembly it is usually desirable to turn fluid grooves on its outer diameter and drill two or more evenly spaced holes for each port.

(6) Slide valves have a small amount of internal leakage and where this can not be tolerated poppet valves are used. The poppet valve shown is of the closed center type and in the neutral position has all poppets closed. If the camshaft were turned so that poppets (B) and (D) were raised off their seats fluid would flow from the pressure port to the cylinder port 1 and from cylinder port 2 to the return port. Raising poppets (A) and (C) would cause flow in the reverse direction. Rearrangement of the cams on the camshaft allow the valves to have other characteristics. For example, a closed pressure open center type can be made by having cams (A) and (D) hold their respective poppets open when the valve is in the neutral position. A closed cylinder open center type can not be obtained unless many changes, not shown on the diagram, are made.

(7) In a one piece construction it is possible to partially balance a poppet by adding a balancing plunger. If it is desirable to overbalance the poppet a design of two or more pieces is inevitable.

(8) A metering selector valve has a restriction to pressure flow and a free return flow. This is accomplished by the use of restricted check valves placed in the cylinder ports. Some metering valves incorporate a means of changing the amount of restriction as the control handle is moved.

grooves on the plunger are sufficient. If a sleeve is used in the valve it is usually desirable to turn fluid passages on its outer diameter and drill two or more evenly spaced holes for each port.

When it is desired that the valve abruptly change conditions of flow, as might be the case where an exact positioning of a device were required, it is usually best to make a slide valve with undercuts at the ports. For this condition the edges of the undercut and the plunger lobe should be made sharp so that a few thousandths of an inch movement of the plunger, when it is near cut-off position, will rapidly change the area of the port opening. Correctly machined these valves are capable of holding pressure, with only a few drops per min. leakage, when the overlap of the lobe and the port is as little as 0.002 in. All parts must be hard in order to cut down the effects of wire drawing.

When the opposite effect, or slow closing, is desired the ports can be made tapering in width or the plunger lobes slightly tapered in diameter. This gradually reduces the area for flow and considerable movement of the plunger is necessary between the beginning of cut-off and complete closure.

Poppet type selector valves are more varied in design than slide valves and are used when leakage cannot be tolerated. Poppet valves are not readily adaptable to the many special conditions where slide valves are used. The poppets themselves are made in many styles and from a wide variety of materials. Some are simply precision balls while others are conical in form and may be guided by longitudinal ribs on the head, longitudinal ribs on the stem, or by the stem itself. Although guides were only mentioned for the conical poppets it is necessary to guide ball poppets to prevent vibration which not only is annoying but tends to batter the seats thus causing leaks. Poppet valves do not seat instantly. If the seat is made sharp it has line contact with the poppet and the valve will close quickly, while a wide seat giving an area of contact will close slowly. An exception to the line contact causing rapid closing is a ball poppet in a tapered hole, and while there is line contact this style of valve usually closes slowly. The disadvantage of line contact is that wear occurs giving area contact.

Ball or ordinary poppets will open when there is a higher pressure below than above the seat, and advantage is taken of this property. However, it is perfectly possible to balance poppets. A one piece construction can partially or nearly completely balance a poppet but if it is desired to overbalance it a design having two or more pieces is necessary. There are advantages, from an operating standpoint in partially balancing poppets because this reduces

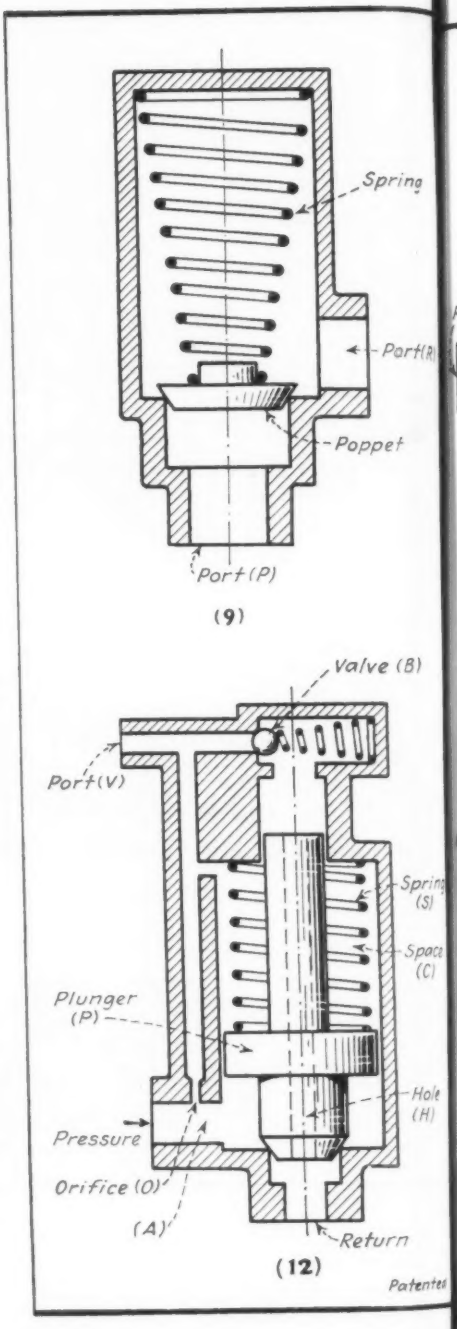
(9) The simplest type of relief valve consists of an unbalanced poppet held to its seat by a strong spring. Port (P) is connected to the circuit to be relieved. When the pressure acting below the poppet becomes greater than the spring will resist, the poppet rises thus allowing fluid to escape through port (R) and maintain the desired pressure at port (P).

(10) To secure a non chattering relief valve the flow is relieved through a slide valve which is opened by a piston, frequently a part of the slide. The return port (R) may be shaped to give any type of gradual opening necessary to accomplish smooth action. The valve as shown has a longitudinal passage through the plunger to prevent trapping of fluid in the spring housing. This has the advantage that only the annular area between the slide valve portion of the plunger and its larger head is effective. This permits the use of a light spring. The fluid in the chamber (A) may be restricted in its egress to the return line thus damping the valve. The slide valve type of relief valve has a small continuous leakage even when closed.

(11) A variation of the poppet type relief valve is the semi-balanced design which has the advantage of being tight when closed but still can use a light spring.

(12) Another type of relief valve is pilot operated. A plunger (P) is held to its seat in the body by a spring (S). Return pressure is transmitted through hole (H) and acts on the tail of the plunger which is equal in area to the seat, thus the plunger is in hydraulic balance insofar as return pressures are concerned. An orifice (O) permits a small amount of fluid to bypass the enlarged portion of the plunger. At low pressures the plunger is hydraulically balanced with respect to the pressure in (A). When the pressure increases the small pilot valve (B) permits bypassing of a fluid from space (C) to return, the result is that the pressure in space (A) is greater than that in (C) because the orifice (O) restricts rate of flow between these spaces. With the plunger unbalanced it rises and allows fluid to flow to return at a sufficient rate to maintain a uniform pressure. Connection can be made to port (V) and remote valves used to control the action of the main valves.

(13) An extension of this piloted relief valve scheme is used as a flow control valve. This valve not only maintains a uniform rate of flow, regardless of the pressure (a thing which a needle valve cannot do), but acts to limit the maximum pressure which can be attained. The principle of the flow control portion of the valve is that of maintaining a constant differential pressure across a flow restriction. The pressure entering the valve acts upward against the plunger (P) and the pressure downstream from the adjustable restriction (R) acts downward against the plunger. A predetermined amount of unbalance is maintained by the spring (S) which also acts downward. If the pressure tends to build up higher than the setting of the pilot relief valve, it opens, thus bypassing some of the downward acting fluid and permitting the plunger to rise.



the handle loads. In an unbalanced valve it is necessary to apply enough force to lift the poppet against the pressure. This involves a real effort as, for example, a poppet having a seat only 5/16 in. diameter will require 76 lb. to lift it against 1,000 lb. per sq. in. Lifting two poppets at once can be avoided by arranging the cams to lift the return poppet prior to the pressure poppet.

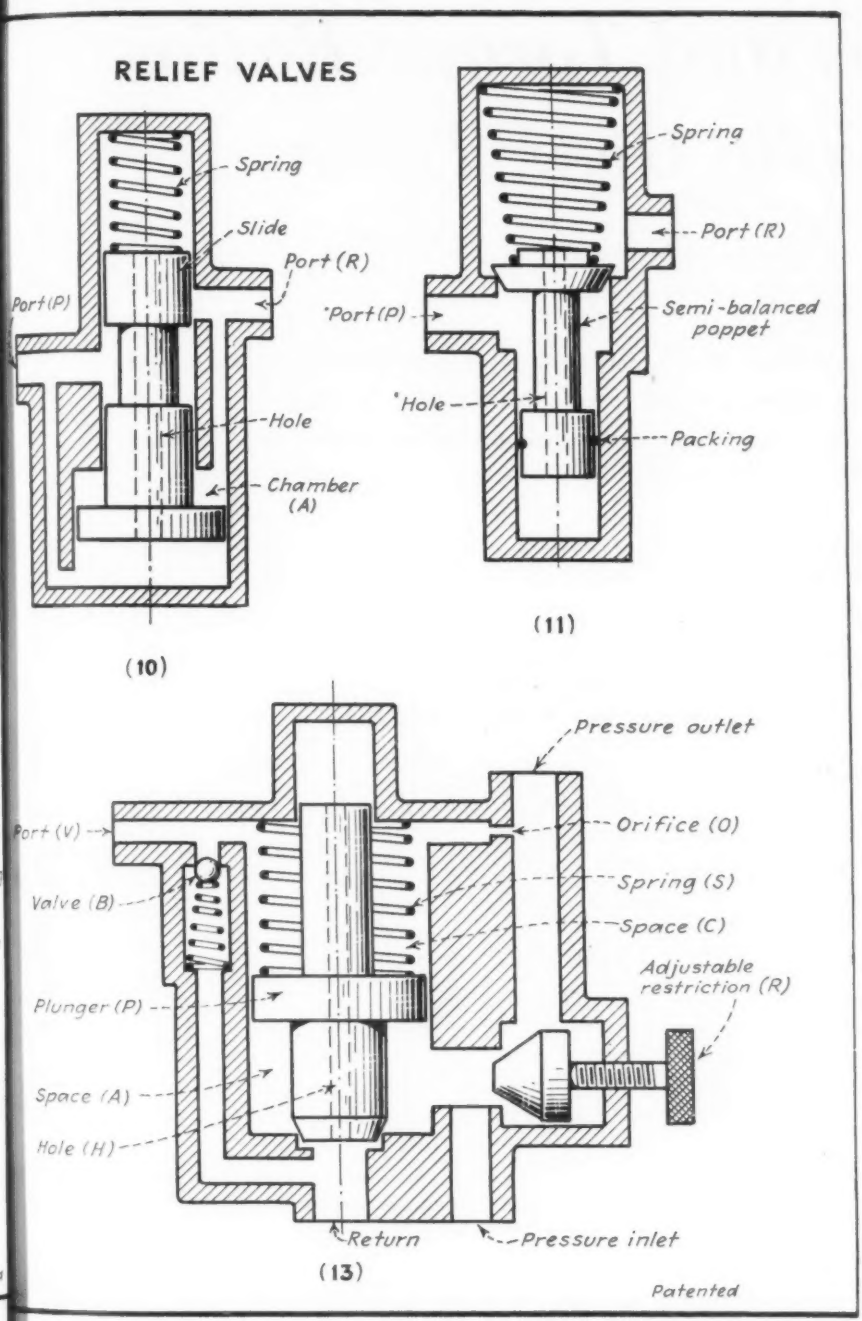
Poppet selector valves can be arranged with the poppets in line similar to a 4 cylinder gasoline engine. This requires a long camshaft with four cam surfaces, but usually makes a valve having convenient tube connections. In some designs poppets are arranged radially which, while contributing to a simple camshaft, generally imposes an inconvenient disposition of tube connections. Valves having the poppets arranged in a square require a costly face cam to lift the poppets, if rotary control is necessary, but a simple lever pivoted between the poppets can be used for actuation if push-pull control is desired. By placing adjustable lifters at each poppet the action of the valve can be set to suit conditions.

Where convenience in repair or replacement of parts of the valve are of importance there is a growing tendency to use a cartridge type of construction. The poppet, its seat, its stem seal and its return spring are contained in a unit which can be pretested and readily installed.

There has been much recent publicity about metering selector valves, which are simply valves that have a restriction to pressure flow but free return flow. This can be accomplished in a number of ways but all are, in effect, leaky check valves in the control lines. When a snubbing action is desired the check valves are merely reversed thus restricting the return flow instead of the pressure flow. Some of these metering valves incorporate a means of changing the amount of restriction as the control handle is moved.

Relief Valves

Relief valves are intended to limit the maximum pressure in the system to which they are connected. All relief



valves have a certain amount of "droop," that is, the pressure is a little lower for low rates than for high rates of flow through the valve. The simplest type of relief valve has a large "droop," and consists of an unbalanced poppet held to its seat by a strong spring. When the pressure acting below the poppet becomes greater than the spring will resist, the poppet rises thus allowing fluid to escape through a port. In a properly designed relief valve the poppet will only rise far enough so that the pressure drop in the fluid being relieved will give the required pressure. Many valves require damping to prevent chattering. If the spring is short, with a high spring rate, the "droop" is large but there is little tendency to chatter. If constant pressures must be maintained long springs with low spring rates are used.

Another way to secure a non chattering valve is to relieve the flow through a slide valve which is opened by a piston. This piston is frequently part of the slide valve. The slide valve type of relief valve, even when closed, has a small continuous leakage. A variation of the poppet type relief valve is a semi-balanced design which has the advantage that it is tight when closed but still can use a light spring. There are many relief valves identical to these from a functional stand-point but details of construction are different. Some have the valve seat in the movable part.

The other main type of relief valve is represented by the pilot operated relief valves made by Vickers, Inc. These valves can give remote adjustment of pressure in one or more locations. The main pilot relief valves should be set to the maximum safe pressure because the main valves are controlled by the lowest pressure to which any pilot valve is set. If the remote valve were a simple shut-off valve opening it to return would relieve the pressure in the system controlled by the main valve.

Valves used in hydraulic systems can be of many designs to suit the uses and characteristics required. Single or multiple valve units can be purchased but they must be selected with care in order to avoid too great a compromise in the characteristics of the hydraulic system. It is often better to manufacture a special valve having the proper characteristics. Some valves described in this article are of patented design and, if used, must be purchased from a licensed manufacturer.

[Forthcoming articles in this series will discuss filters, accumulators, specialties, and theories of circuit design.]

Chromate-Impregnated Felt As a Gasket Material

CONSISTING of a felt base impregnated with a chromate pigmented compound which renders the material resistant to fire and corrosion, a recently developed gasket material announced by the Sherwin-Williams Company was originally intended as a substitute for low-pressure rubber gaskets in marine ventilating systems. The new gasketing has since demonstrated its usefulness in many other applications, including joint seals in water, fuel-oil and diesel-oil systems as well as gasketing for air lock and refrigerator doors, air lock relief valves, and flame-resistant closures. Besides being resistant to fire, chromated gasketing can withstand relatively prolonged exposure to salt water.

Base material of chromated gasketing is a good grade of thoroughly felted, low shoddy-content wool felt. This is impregnated with a specially prepared chromate-pigmented compound which is non-drying, tack and water insoluble and renders the felt flexible, pressure-resistant and flame-resistant.

Gaskets of this type will retain air pressures up to 25 lb. per sq. in. at normal temperatures. They are not affected by fuels and, in addition, have rust-inhibiting properties. Chromate gasketing is dark green in color and is available in 1/8- or 1/16-in. thicknesses. It can be either factory pre-cut or cut from sheet at the point of use without special tools.

Speed Ratios and Torque Ratios In Epicyclic Gear Trains

EDWARD F. OBERT
Northwestern Technological Institute

Method for calculating input and output speed ratio from torque relationships in epicyclic gear trains that emphasizes magnitude of torque transmitted by individual gears in the system. The analysis deals with simple and compound gear trains. An example is included to show relative division of torque in a system where power circulates.

SPEED RATIOS between driver and driven shafts in epicyclic trains usually are determined by compiling a kinematic tabulation and summation of the relative motions of each gear in the train. Such an analysis, while simple, does not give the engineer the necessary information on the magnitudes of the forces and torques existing within the train upon which to base a design. Since torque data affects design, it appears logical to determine speed ratios from torque relationships.

In any geared train the speed reduction at any point in the mechanism is achieved by a proportionate increase in the torque. Hence, computation of the torque relationships between geared members of a train leads directly to speed relationships. Assume two gears A and B mate with each other and that

ω_a = r.p.m. of gear A about its axis
ω_b = r.p.m. of gear B about its axis
T_a = torque on gear A
T_b = torque on gear B

$$\frac{\omega_a}{\omega_b} = \frac{T_b}{T_a} \qquad (1)$$

The ring or internal gear A of radius R_a, Fig. 1, drives a planetary gear B which "walks" around the fixed or sun gear D thus rotating the planetary spider link C of radius R_c. Let the driving torque be $F_a R_a$. From inspection, or by moments around the axis, evidently the force F_a is exerted by gear A on gear B and the same force F_a by gear D on gear B. Using the plus sign to indicate torque that causes counterclockwise rotation

Torque on driving shaft $T_a = + F_a R_a$
Torque on driven shaft $T_c = + 2 F_a R_c$

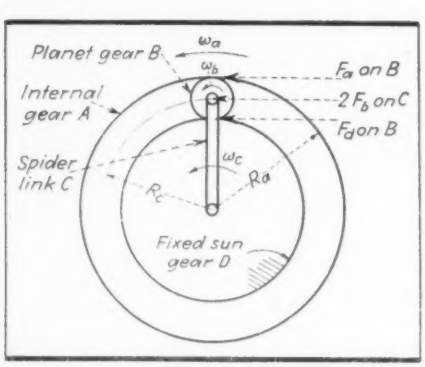


Fig. 1—Epicyclic gear train consisting of a driven internal gear, a planet gear mounted on a pin in spider link, and a fixed sun gear.

In analyzing a system, rotation should be viewed from one end of the mechanism, in general the driving end. Forces causing counterclockwise rotation of the link in question will be considered positive forces.

Then from Equation (1) and using D (with a subscript) to designate the diameter of the respective gears, the ratio of the r.p.m. of gear A to the r.p.m. of spider link C is

$$\frac{\omega_a}{\omega_c} = \frac{T_c}{T_a} = \frac{2 F_a R_c}{F_a R_a} = \frac{2 (D_d + D_b)}{D_a}$$

$$= \frac{2 (D_a - D_b)}{D_a} = 2\left(1 - \frac{D_b}{D_a}\right) \qquad (2)$$

Also, since the gears must have the same pitch, and using N (with subscript) to designate the number of teeth in each gear

$$\frac{\omega_a}{\omega_c} = \frac{2 (N_d + N_b)}{N_a} = 2\left(1 - \frac{N_b}{N_a}\right) \qquad (3)$$

In the compound gear train, Fig. 2 (A), gear A drives gear B which is fastened to gear C. Gear C walks around the fixed gear D thus rotating arm E. The resultant torque on arm E arises from the force exerted on arm E through gear B and the force on arm E through gear C. In Fig. 2 (B) which shows gears A and B, let the driving torque T_a on gear A be

$T_a = + F_a R_a$
Force of gear A on gear B
$= - F_a$ (− for rotation about B axis)
Force of gear B on arm E
$= + F_a$ (+ for rotation about E axis)
Torque (partial) on arm E
$= + F_a R_e = + F_a (R_a + R_b)$

In Fig. 2 (C) are shown gears C and D and arm E.

Torque on gear $C = T_c = - F_a R_b$

Force of gear D on gear $C = + \dfrac{F_a R_b}{R_c}$

Force of gear C on arm $E = - \dfrac{F_a R_b}{R_c}$

Torque (partial) on arm E
$$= - \frac{F_a R_b R_e}{R_c} = - \frac{F_a R_b (R_c + R_d)}{R_c}$$

Therefore the resultant or total torque T_e on arm E is

$$T_e = F_a \left[(R_a + R_b) - \frac{(R_c + R_d) R_b}{R_c} \right]$$

$$= F_a \left[\frac{R_a R_c - R_b R_d}{R_c} \right]$$

Again using Equation (1)

$$\frac{\omega_a}{\omega_e} = \frac{T_e}{T_a} = \frac{F_a (R_a R_c - R_b R_d)/R_c}{F_a R_a}$$

$$= 1 - \frac{R_b R_d}{R_a R_c} \qquad (4)$$

The driven shaft revolves in the opposite direction to the drive shaft when the sign of Equation (4) is negative.

For gears having the same pitch, Equation (4) can be written by using N (with subscript) for number of teeth in each gear

$$\frac{\omega_a}{\omega_e} = 1 - \frac{N_b N_d}{N_a N_c} \qquad (5)$$

A complicated gear system is shown in Fig. 3 wherein the drive is through compound gear AB to gears C and D. Compound gear DE drives compound bevel gear FG which is also driven by gear C to walk around gear E and drive gear H connected to the driven shaft.

Since the torque on the driving shaft is delivered to gears A and B and the relative division on torque is unknown, it will be necessary to start the analysis from gears G and H.

Let $- F_h R_h$ be the torque transmitted by gear H to the system.

Torque on gear A through gear C

(*a*) Force of gear H on gear $G = - F_h$
Since the force acting on the pitch circle of

gear G is resolved into a force acting on the axis of the gear and a couple, the torque on gear C from gear $G = -F_h R_h$

(*b*) Torque on gear $G = T_g = F_h R_g$ (no sign desired).

(*c*) Force of gear E on gear $F = -\dfrac{F_h R_g}{R_f}$

Hence torque on gear C from gear $F = -F_h R_g R_e/R_f$

Summation of torque on gear C

$T_c = -F_h (R_h + R_g R_e/R_f)$ Negative or clockwise torque.

(*d*) Force on gear $A = +\dfrac{T_c}{R_c}$

(*e*) Torque T_a on gear A through gear C,

$$T_a = +\frac{T_c R_a}{R_c}$$

$$= +F_h \left(R_h + \frac{R_g R_e}{R_f} \right) \frac{R_a}{R_c} \qquad (6)$$

Torque on gear B through gear D

From (*c*)

Force of gear F on gear $E = +\dfrac{F_h R_g}{R_f}$

Torque on gear $E = T_e = +\dfrac{F_h R_g R_e}{R_f}$

Force of gear D on gear B, $= +\dfrac{F_h R_g R_e}{R_f R_d}$

(Note idler for proper sign)

Torque on gear $B = T_b$

$$= +\frac{F_h R_g R_e R_b}{R_f R_d} \qquad (7)$$

Total torque to shaft driving gears A and B

$$T_a + T_b = T_{ab}$$

$$= F_h \left[\left(R_h + \frac{R_g R_e}{R_f} \right) \frac{R_a}{R_c} + \frac{R_g R_e R_b}{R_f R_d} \right]$$

Using Equation (1)

$$\frac{\omega_h}{\omega_{ab}} = \frac{T_{ab}}{T_h} = -\left[\left(R_h + \frac{R_g R_e}{R_f} \right) \frac{R_a}{R_c} + \frac{R_g R_e R_b}{R_f R_d} \right] \Big/ R_h$$

$$= -\left[\frac{R_g Re}{R_f R_h} \left(\frac{R_b}{R_d} + \frac{R_a}{R_c} \right) + \frac{R_a}{R_c} \right] \qquad (8)$$

Where as before the negative sign indicates the driven and driver shafts revolve in opposite directions.

If the idler gear in the gear train shown in Fig. 3 is removed, the torque on gear A through gear C remains unchanged but the torque on gear B through gear D changes sign and torque T_{ab} equals T_a plus $-T_b$, hence

$$\frac{\omega_h}{\omega_{ab}} = \frac{R_g R_e}{R_f R_h} \left(\frac{R_b}{R_d} - \frac{R_a}{R_c} \right) - \frac{R_a}{R_c} \qquad (9)$$

In this case, the driver and driven shafts revolve in the same direction when the sign of Equation (7) is positive, and revolve in opposite directions for negative values of sign.

It is interesting to note that when the torque of the driver is T_a plus $-T_b$, it follows that the power transmitted through gear A is greater than the input power by the amount of the return or circulating power through gear B. (See "Limitations of Epicyclic Gearing for Variable-Speed Drives," J. F. Allen, PRODUCT ENGINEERING, October, 1944.) Analysis by torques readily reveals circulating torques. Note that in the preceding discussion the two torque paths obtained by using an idler gear were additive and hence not objectionable.

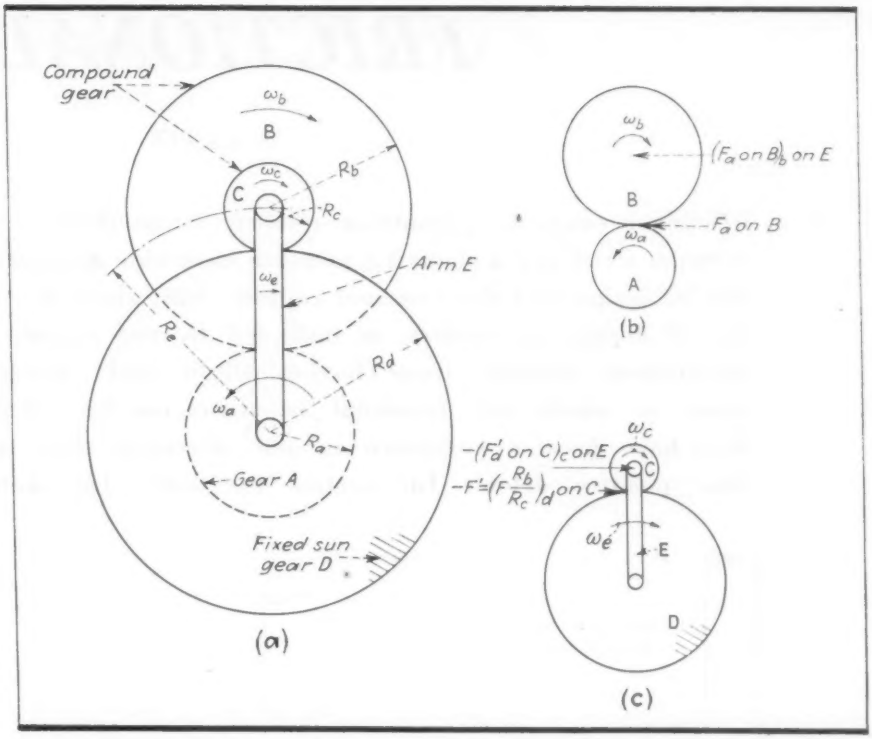


Fig. 2—Compound gear used as planet gear in an epicyclic gear train. Rotating arm turns about axis of sun gear.

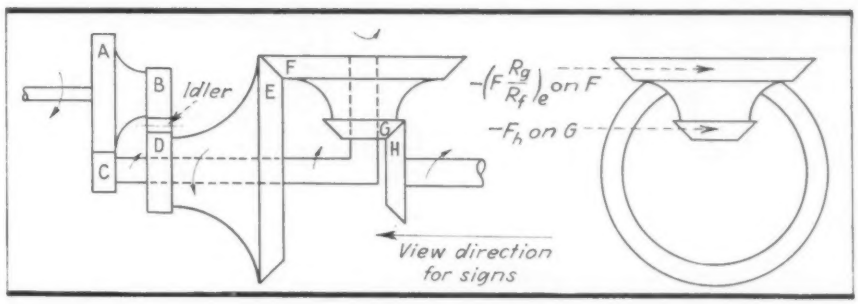


Fig. 3—An elaborate epicyclic system consisting of spur and bevel gears in which there is no fixed sun gear.

An example will illustrate a system in which a circulating torque is present.

In a gear train similar to that of Fig. 3, but with the idler removed, let

$R_h = R_d = 12$ in.
$R_g = R_b = R_a = R_c = R_f = 24$ in.
$R_e = 96$ in.

Substituting these values in Equation (9)

$$\frac{\omega_h}{\omega_{ab}} = 8\,(2 - 1) - 1 = 7$$

Let $\omega_h = 700$ r.p.m.
$\omega_{ab} = 100$ r.p.m.

Then from Equation (6)

$$T_a = F_h \left(12 + \frac{24 \times 96}{24} \right) \frac{24}{24} = 108\ F_h$$

And from Equation (7)

$$T_b = -F_h \frac{24 \times 96 \times 24}{24 \times 12} = -192\ F_h$$

(− for case without idler)

Total torque T_{ab} on shaft driven by gears A and B

$T_{ab} = T_a + T_b = F_h\,(108 - 192) = -84\,F_h$

Torque T_h on shaft which drives gear H

$$T_h = \frac{T_{ab}\ \omega_{ab}}{\omega_h} = -\frac{84\ F_h}{7} = -12\ F_h$$

Considering F_h to be 1 unit of force, note that 12 torque units are transmitted by gear H at a speed of 700 r.p.m. and that 84 torque units at a speed of 100 r.p.m. are delivered by the shaft upon which the compound gear AB is fastened. But the torque transmitted back into the gear system by gear B is 192 units at 100 r.p.m. If the gear train is a 100 hp. speed reducer,

$$100 \times 192 / 84 = 228 \text{ hp.}$$

is transmitted through gear B, and 128 hp. circulates through the system.

This basic method of using torque ratios for speed relationships in epicyclic trains calls attention to excessively high tooth and bearing loads.

FRICTIONAL SUPPORTS

L. KASPER

Frictional supports permitting relative longitudinal and rotational adjustment between a rod and a clamping member have wide application because of their simplicity of design and the ease and rapidity with which they can be adjusted. Possibilities of design are endless, as indicated by the accompanying group of designs. Illustrations include types having slight and strong resistance to friction, types in which the frictional resistance can be varied to suit conditions, types that have greater resistance in one direction than the other, and types that have positive detents for certain positions. The sketches are self-explanatory.

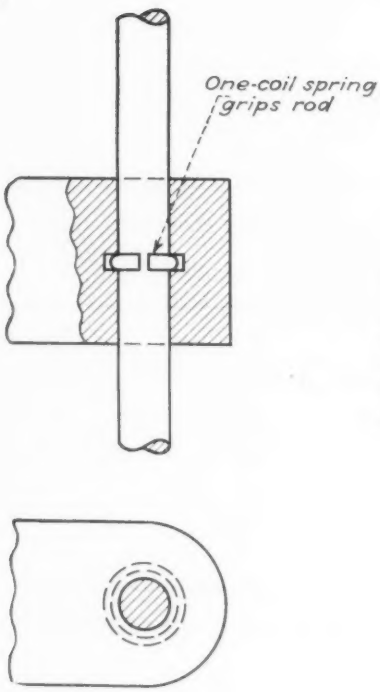


FIG. 1

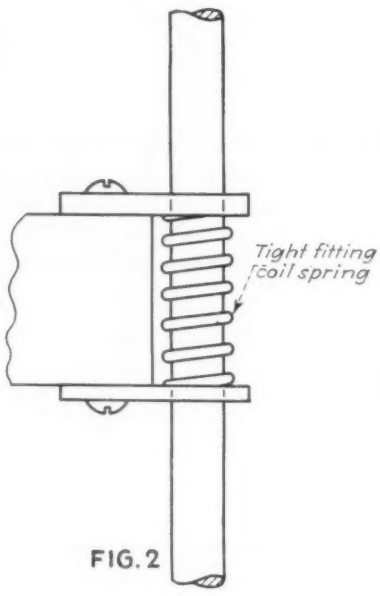


FIG. 2

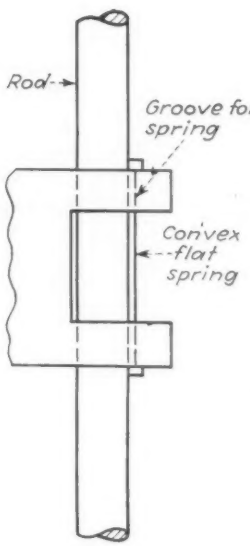


FIG. 3

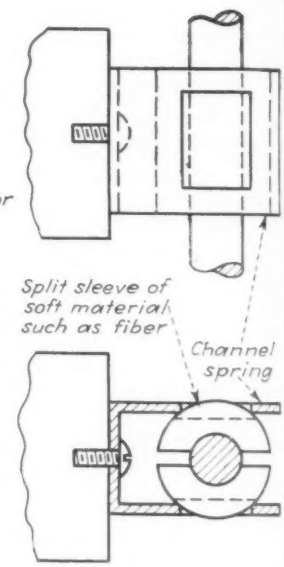


FIG. 4

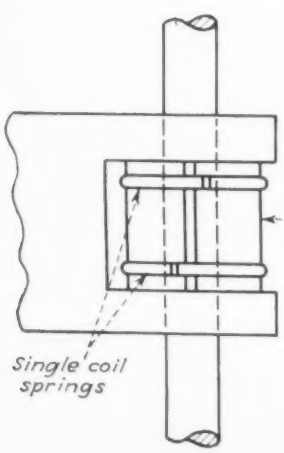


FIG. 5

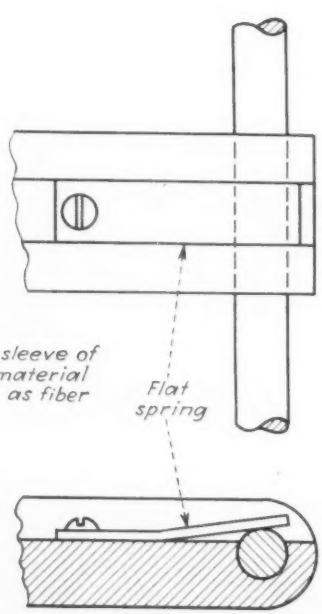


FIG. 6

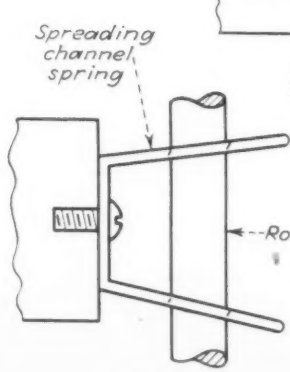


FIG. 7

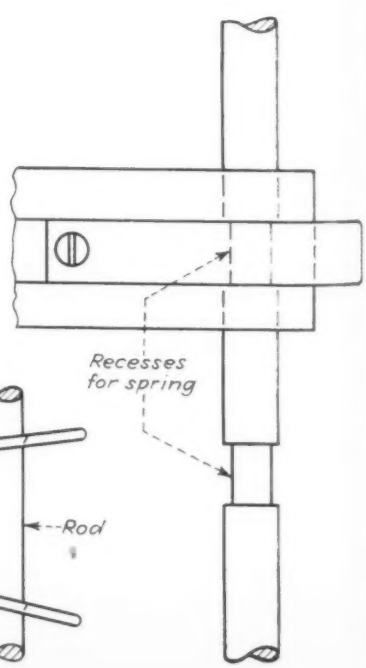


FIG. 8

FOR ADJUSTABLE PARTS

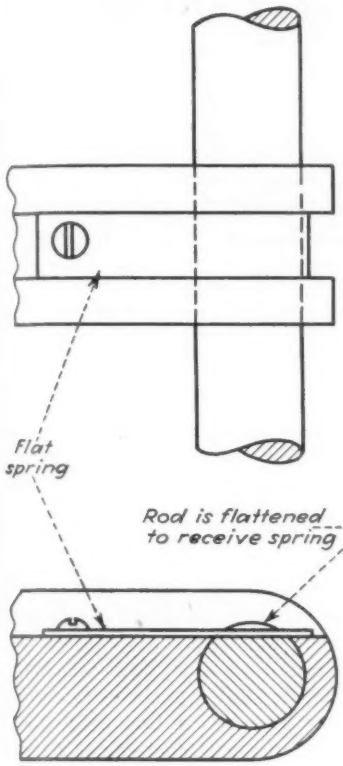


FIG. 9

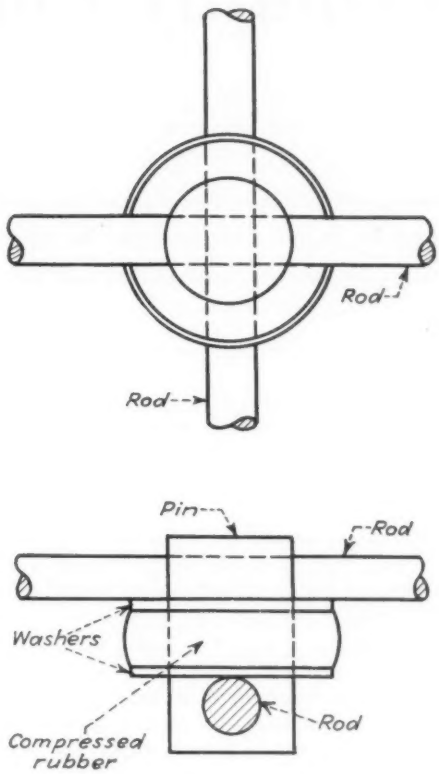


FIG. 10

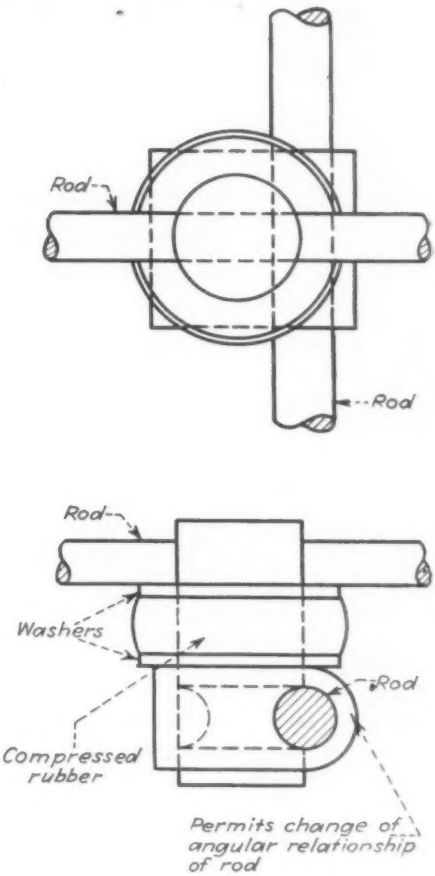


FIG. 11

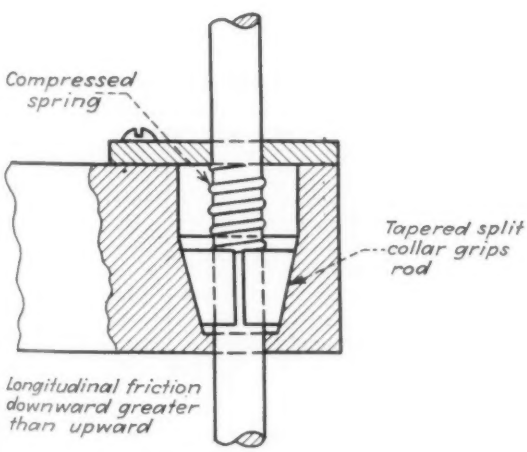


FIG. 12

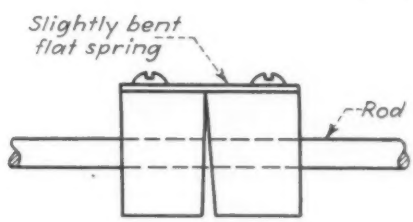


FIG. 13

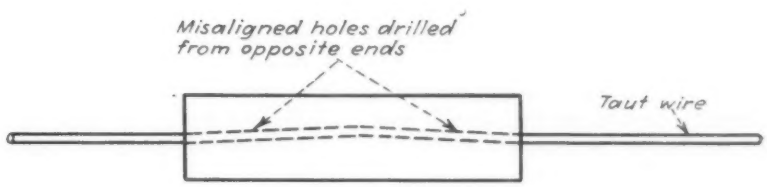


FIG. 14

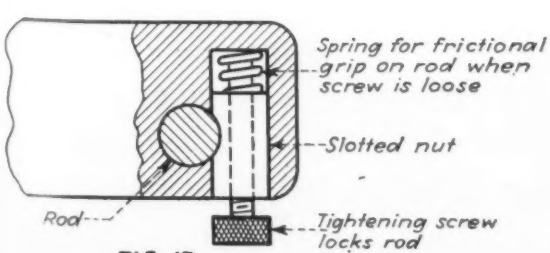


FIG. 15

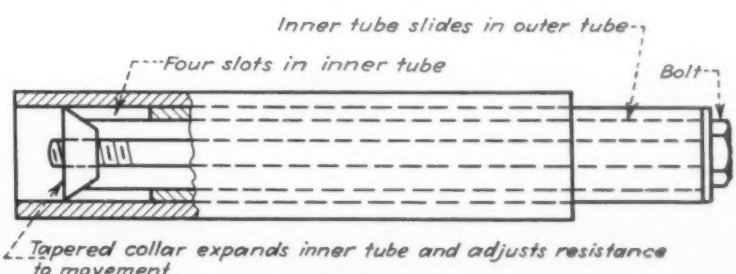

Inner tube slides in outer tube
Four slots in inner tube
Bolt
Tapered collar expands inner tube and adjusts resistance to movement

FIG. 16

Brazing Small Assemblies— A Cost and Quality Comparison

O. A. KEHLE
Chief Design Engineer, Adel Precision Products Corporation

Small, complicated parts are analyzed for possible production as furnace-brazed subassemblies. Cost comparisons between brazed assemblies and machined parts or forged and machined parts are included.

AS IS true for every manufacturing process, a complete comparative evaluation of brazing is not obtained when only the cost of the operation itself is considered. Other factors that must be investigated include the cost of the parts when ready for assembly, preliminary operations, such as cleaning, and finishing operations that might have to be performed after brazing. Degree of inspection required, and percent of scrap loss must also be considered.

Frequently when a complicated part is designed as a brazed assembly the greatest economies result from the low cost of the simpler component parts. Castings or forgings that are substantially of the form of webs with ribs and bosses, can be redesigned as a brazed assembly of stampings and screw machine parts. Pattern or forging die costs are then avoided and machining operations are greatly simplified with resulting lower costs. Similarly, machined parts having the form of cylinders with large diameter flanges might be replaced with cold rolled bars brazed to the stamped flanges, possibly requiring machining of only the inside diameter of the piece.

Quite often the unit to be made as a brazed assembly can be broken down into small parts such as stampings, simple screw machine parts, bent rod or wire forms, or even standard parts such as bolts, studs and plate washers. In no case are costly machining operations involved as only the fitting surfaces need be accurate. For male and female fits an interference of about 0.001 in. per in. diameter is used, but such a press fit is not essential. A clearance of 0.001 in. gives good results with strength of copper brazed joints about 20,000 lb. per sq.in. An interference fit may increase the strength up to 32,000 lb. per sq.in.

In the following some case histories are reported to illustrate the economies achieved by introducing brazing to the manufacture of small component parts of control instruments, while maintaining the quality of the product.

CASE 1: MANUFACTURE OF COAXIAL CAMS

COAXIAL CAMS can be made by forging, by upsetting, by machining or by hydrogen furnace brazing.

FORGINGS were used originally in this application. However, lack of concentricity and warping, combined with difficulties in straightening and cleaning, and imperfections such as laps, folds or cracks, resulted in a high rate of rejections and finally in the abandonment of this production method. In addition, a further loss of 20 percent due to flash and short ends is incurred during the manufacture of forgings.

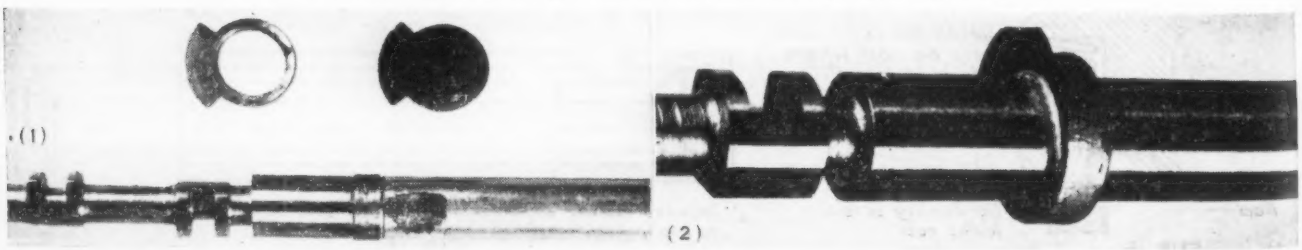
BAR STOCK UPSET results in considerable material savings, but inspection requirements and rejections are still high for causes similar to those outlined *above* in the case of forgings. Speedy and economical machining of coaxial cams from blanks would of course entail the use of automatic lathes.

MACHINING OF BAR STOCK is the method presently in use. Cams are turned from 1-in. bar and the stop is then milled. This method may be wasteful of materials and, in addition, expensive in labor.

Table I—Cost indexes brazing = 100

Method of Manufacture	Mfg. Cost	Material Cost	Total Cost
Machined from 1-in. dia. rod	108	148	109
Manufactured from forgings	109	239	112
Mfd. in parts and furnace-brazed	100	100	100

Fig 1—Blanked stop, drilled stop and machined shaft of cam assembly before brazing. Fig. 2—Camshaft assembly after brazing.



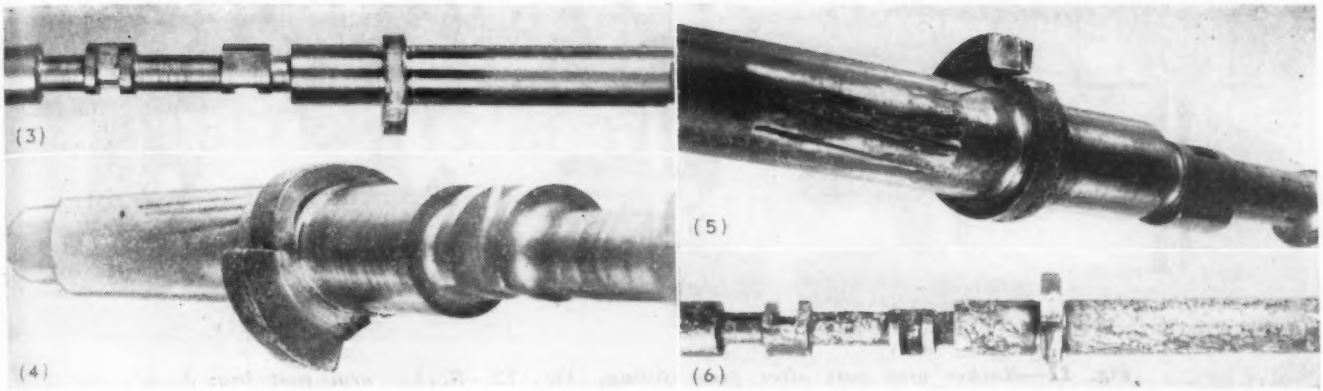


Fig. 3—Camshaft assembly after machining small brazed fillets. Fig. 4—Torque-test failure at 1,770 in. lb., view 1. Fig. 5—Torque-test failure at 1,770 in.-lb., view 2. Fig. 6—Camshaft assembly after 96 hr. in salt spray.

HYDROGEN FURNACE-BRAZING permits the use of smaller diameter bar stock. Here the stop, produced as a stamping, is copper-brazed to the bar and considerable savings are earned in critical material and manufacturing time. A manufacturing cost comparison in relative terms is shown in Table I, which is based on a production run of 500 parts, perfect results and does not include the cost of rejections.

A number of tests were performed to determine the mechanical suitability of the brazed assembly. Two specimens tested for ultimate static torque failed at 1,770 and 1,580 in.-lb. and had a calculated shear strength of 25,000 and 22,000 lb. per sq.in. Failure under these loads was, however, incomplete and the actual shear strength is probably much higher than calculated. In a manually applied impact test no failure of any kind was observed. Corrosion resistance of the brazed assembly was tested in a salt spray test over a period of 96 hours, it was found that the metal in and adjacent to the joint was attacked less severely than the rest of the specimen.

As a result of this cost and quality investigation the use of hydrogen-brazing in the manufacture of coaxial cams was advocated. In the production of one order of 44,000 cam shafts about 45,000 lb. of SAE 4615 or NE 8620 and $29,000 could be saved.

CASE 2: MANUFACTURE OF FITTING-SHUTTLE VALVES

FITTING-SHUTTLE VALVE, machined from 2-in. diameter bar, requires milling of the flange, which is expensive in time, material and production costs. Hydrogen furnace-brazing allows the production of the part from two sections, a stamped flange, and a turned fitting which are joined and copper-brazed. Savings permit the use of a better quality material. A relative cost comparison is shown in Table II, based again on 500 parts, perfect results and no rejections.

Tests indicate the shear strength of the copper-brazed fitting joint as 32,400 lb. per sq.in. In a 62 hour fatigue strength test a load of 460 lb. was applied in shear and tension, which is equal to 1,500 lb. per sq.in. of hydraulic pressure. Vibrations applied were of an amplitude of 0.040 in. and a frequency of 2,800 cycles per min., and total 10,416,000 vibration cycles. A careful examination of the assembly before and after test under a low-power microscope revealed neither any kind of incipient rupture nor any other impairment of the valve. The corrosion resistance of the brazed fitting-shuttle valve should parallel that obtained in the salt spray test of brazed camshaft assembly.

Table II—Cost indexes, brazing = 100

Method of Manufacture	Material Cost	Mfg. Cost	Total Cost
Machined from 2-in. dia. Bessemer Bar Stock	405	135	142
Manufactured in two parts and copper-brazed	100	100	100
Average saving per unit	305	35	42

Parts manufactured by hydrogen furnace-brazing have adequate strength and vibration resistance for this application. (*continued on next page*)

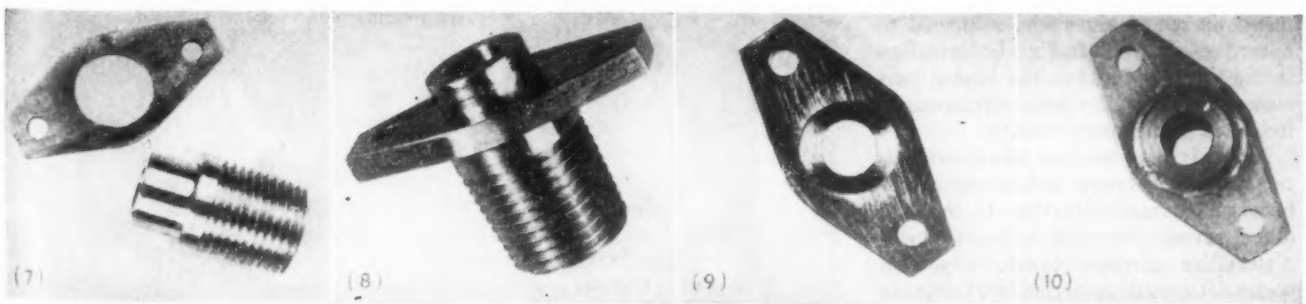


Fig. 7—Parts of fitting-shuttle valve: stamped flange and turned fittings. Fig. 8—Flange and fitting after press-fitting. Fig. 9—Flange and fitting after press-fitting. Fig. 10—Assembly after brazing.

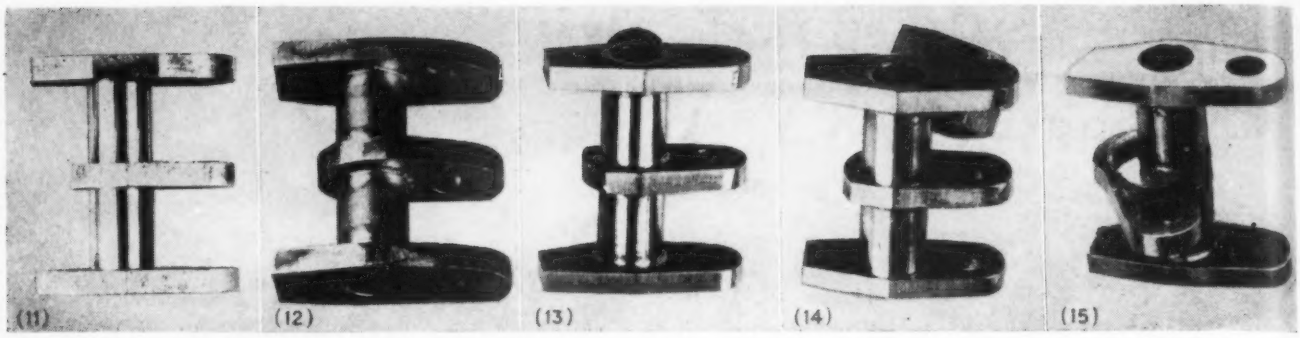


Fig. 11—Rocker arm part after press fitting. Fig. 12—Rocker arm part brazed, but not machined. Fig. 13—Rocker arm part brazed and machined. Fig. 14—Rocker arm part brazed and machined. Fig. 15—Rocker arm part after destructive test.

CASE 3: MANUFACTURE OF ROCKER ARM

ROCKER ARM of the solenoid reversing valve is now produced from solid bar stock. When hydrogen furnace-brazing is used, three links cut from sheet are press-fitted to a shaft and the joints are copper brazed. Old and new production methods are compared for relative costs, as shown in Table III.

In testing this part, the center link was subjected to a load until failure occurred at 1,490 lb. This result is thought to establish the applicability of the production method.

Table III—Cost indexes, brazing = 100

Method of Manufacture	Part Made	Material Cost Per Unit	Total Cost
Machined from Solid Bar Stock		171	161
Brazed from Sheet Stock and Tubing	End links (2)	19	27
	Center link	13	11
	Tube	68	9
	Assembly, braz., finishing		53
	Total	100	100
Average Saving per Unit			61

CASE 4: MANUFACTURE OF RETAINERS

RETAINERS are at present cut from bar stock, and manufacture requires removal of a large amount of material, and considerable machining. Operations are costly and rejections high.

In brazing, the base plate is stamped and the half ring formed from either strip, or seamless tubing of suitable thickness. A 24-gage copper wire produces a sound joint. Relative costs are given in Table IV.

In subsequent tests the strength of the copper-brazed assembly was tested by applying 100 hammer blows to the contact faces between camshaft and half ring. Examination showed indentation and fracture in the ring, but no damage to the brazed joint. In another test a brazed retainer was subjected to a torque of 2,000 in.-lb. Deformation in the machined and in the brazed part was identical. Also here performance indicated satisfactory service.

The only factors taken into consideration in these reports are those of materials and manufacturing. In brazing, other savings than those shown will materialize through lower inspection cost, decreased rejections, over-heads and plant investment. The versatility of a furnace-brazing installation is another factor worth considering. The

Table IV—Cost indexes, brazing = 100

Method of Manufacture	½ ring made of	1 in. size Retainers			1¼ in. size Retainers		
		Mat'l Cost	Total Cost	Brazed "Strip" Costs Saved	Mat'l Cost	Total Cost	Brazed "Strip" Costs Saved
Machined	Bar Stock	375	170	—	400	188	—
Brazed	Strip	100	100	70	100	100	88
	Seamless Tubing	100	131	39	100	131	57

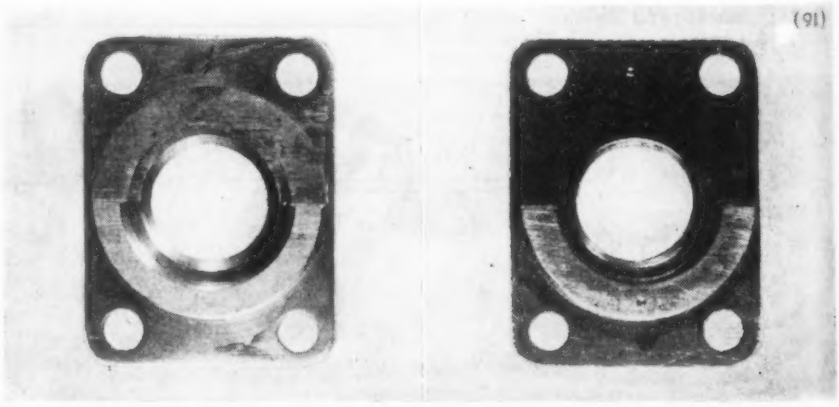


Fig. 16—Retainer; left, after brazing; right, machined from bar stock.

INDUSTRY AND SOCIETIES

ABSTRACTS of TECHNICAL PAPERS

STANDARDS • READER LETTERS • MEETINGS

Post-Formed Laminates

From "Post Formed Laminates" by J. Roger White, Formica Corporation. Presented Feb. 6, 1945, Canadian section meeting, Society of the Plastics Industry.

The new joint Army-Navy specification JAN-P-13, defining thermosetting materials as "those synthetic resins in which, when subjected to heat and pressure, there occurs a chemically irreversible reaction characterized by transformation of the resins into a hard, infusible material," is not violated by the post-forming process in the author's opinion.

Post forming of flat sheet is accomplished by heating the material rapidly until it loses stiffness, subjecting it to deforming forces, and allowing it to cool, whereby its inherent stiffness returns. Most synthetic resin laminates can be formed to some extent when heated to temperatures in excess of their curing temperatures. Phenolic type laminates, designated as NEMA Grade C material, have proved suitable for post-forming operations. Cotton base fabric and resin are both capable of severe distortion without failure when flash heated. Paper base and combined paper and fabric base phenolic laminated have been considered, but their formability is relatively limited.

Although many usable parts have been formed in Grade C materials, the multitude of possible forming applications made it highly desirable to develop a material having greater formability. Through modification of the resin binder to produce greater pliability at elevated temperature, and by selection of a fabric base that has uniform elongation, it has been possible to increase formability greatly without seriously changing physical properties from the Grade C requirements.

The forming process must be carried out on a rather strict time schedule. There is a relatively short working range between the temperatures at which the material becomes pliable and at which it blisters. Development of forming laminates is concerned with separating these points as much as possible so that the working range will be less critical. Parts made by post forming can be divided into two general classes: those that are bent to shape and those in which two-way stretch occurs. In order to satisfy the widest range, developments in both fabric and resin have been necessary.

Developments in Fabric

The degree to which a forming sheet can be elongated is largely determined by the amount of crimp in the cotton fabric base, which also influences the physical properties of the material. Hence it is necessary that crimp be rigidly controlled. Fabrics used in producing Grade C material normally have 10 to 12 percent crimp in each direction and no attempt is made to control distribution. With the cooperation of fabric manufacturers, the amount and distribution of crimp in each direction of the fabric is now controlled. One manufacturer is producing fabric that has approximately 33 percent crimp in the warp direction and 20 percent in the filling direction. During the impregnating operation the crimp in the warp is decreased and that in the filling direction is increased. Thereby a balanced treated fabric with a crimp of approximately 25 percent in each direction is produced. Laboratory tests on this material have been completed and commercial production is under way.

Resin Developments

Development programs have been carried on by several manufacturers of phenolic type resins to improve the desirable qualities. Progress has been notable:

1. The working temperature range between minimum heating temperature and blistering point has been increased approximately 50 percent.

2. The working time range, from removal from the heating medium to completion of forming operation, has been increased approximately 40 percent.

3. The depth of draw for a spherical cup has been increased approximately 25 percent.

These improvements have been made by modifying the manufacturing process without undercuring the material or adding thermoplastic constituents, thus making it possible to maintain NEMA Grade C requirements for physical strength.

Successful heating methods include radiant heat with infra-red bulbs, circulating and non-circulating hot air, contact with a hot plate, and immersion in a heated liquid. To secure maximum pliability, the blank to be formed should be heated as rapidly as possible without blistering the surface. Optimum time and temperature varies with thickness and heating medium.

Occasionally forming stock can be formed in jigs or molds that have been made for forming aluminum or sheet metal. For most shaping operations all that is needed is hard wood, an assortment of hinges and fasteners, and a lot of ingenuity. Most formed articles have required only simple bending of the material, which is clamped and bent to shape with a hinged section. Handles of various kinds give the necessary leverage, and simple fastening devices hold the material in place. In many instances male and female dies of wood, band-sawed and sanded to required dimensions, can be used. More intricate shapes require guides, pins, and holding devices to insure exact placement in the form.

Drawing operations, similar to those used in drawing metal, require a hold-down plate and a positive means of controlled pressure. Hard wood drawing forms are satisfactory unless several thousand pieces are needed; then it is usually advisable to use metal. Plastic materials, plastic impregnated wood, and composition materials can also be used in forming and drawing tools.

Metal forming tools can be water-cooled if necessary. Usually enough wood, plastic, or composition forms are available to permit air cooling three to

five minutes after closing the form until removal of the formed product. It is often possible to form a piece and in about 30 sec. remove it from the form and transfer it to a cooling frame. If wood forms are likely to overheat, metal fins can be attached to dissipate heat rapidly.

Formed parts have been used mainly for non-structural or simple semi-structural applications. The weight-strength ratio is not sufficiently high for structural application. Use of laminated plastic may depend on its ability to absorb vibration, its light weight, chemical resistance, resilience and stiffness, or resistance to denting.

The drawing operation is a combination of elongation, compression and rearrangement. Material up to 1/16 in. thick can be drawn into spherical cups to a depth of 60 percent of the diameter and into cylindrical cups with a slight radius to 30 percent of the diameter.

Economics of Electronic Heating

From "Experience of a Molder in Using Electronic Heat" by James D. McDonald, McDonald Manufacturing Company. Presented Feb. 6, 1945, Canadian section meeting, Society of the Plastics Industry.

The value of electronic preheating in the molding of plastic parts has been thoroughly proven, but whether it can be extended to the field of general molding is controversial.

In conventional molding of plastic disks at optimum temperature with an unpreheated charge, serious trouble is encountered after the material next to the mold surface begins to set. The hard surface and the unsoftened interior combine to keep the mold from fully closing. As the heat permeates, the center gradually softens and loses its resistance to compression, throwing its share of the load on the semi-hardened wall near the surface. This semi-cured material is forced into movement after it has lost its capacity to rebond with maximum strength. When equilibrium is reached, the disk has a semi-compressed center and localized weakness in the outside structure. Heat by conduction is said to have failed because it hardened the surface. Yet there is nothing basically wrong with hardening the surface. The real trouble was the lack of plasticity of the charge, which kept the mold from closing before hardening.

High frequency preheating furnishes both heat input and plasticity. In heavy sections heat input is important. With smaller pieces and thinner sections, plasticity becomes unimportant. It is more economical to make a larger mold or have the operator run more than one machine, than to attempt to squeeze a few extra seconds out of the curing cycle.

The length of cure necessary to produce a perfectly cured piece has been the subject of much discussion, but there is still confusion and a wide variation of opinion. This is unavoidable as long as the term "perfectly cured" remains undefined. The acetone extraction test is inadequate because it indicates satisfactory cure in parts with the poor surface and low density previously attributed to undercure. This can undoubtedly be explained by the fact that the high internal heat characteristic of electronic preheating permits what might be called "post-ejection curing," so that even a piece extracted from the mold in the semi-rigid state formerly called undercure, may cure outside of the mold sufficiently to pass an extraction test. Such parts respond rapidly to warpage control in chilling forms and appear to have fair physical properties, but in products requiring dimensional accuracy, the change in density after removal from the mold makes control almost impossible.

In good molding practice all movement of material, either by flow or compression, should cease before the material polymerizes or sets to the point where the ruptured molecular bonds cannot be adequately replaced by new bonds. Failure to accomplish this is one of the major reasons for weakened plastic structure and physical properties far below those that can be attained with the same material. If a pre-heated charge allows the mold to close and all flow to cease in five seconds, and the critical point in setting comes at the end of 15 sec., then the ratio of the two times should represent a fair estimate of molding latitude, in this instance three to one. If an inadequate preheat were used, the mold closing time might have been 20 sec. and the critical time 25 sec. Nearly all the latitude is lost while staying within the range of good molding. If the preheat were very uneven the hottest part of the charge may pass the critical point before flow ceases, creating a condition where the latitude is negative and a perfect part impossible. The same, or worse conditions prevail when the charge is preheated to cut curing time. Before efficient preheat was made possible by high frequency, practically all thick sections molded commercially had defective structure.

Volatiles

Volatiles in molding compound have always been a headache for molders. Now volatiles are a plague not only in the mold but in the preheating. Fortunately a complete solution of the problem in the preheater may also solve the trouble in the mold. While the preform heats, vapors form in the interior and are driven out by a rapidly rising vapor pressure. As they escape there is a slight effect at the surface caused by expansion. If the surface is cold enough to cause condensation small blisters and discoloration are sometimes caused.

The effect is amplified if cold plates are used as electrodes, but it can be minimized by using screens or grids instead of solid plates. In spite of all these precautions it still is a problem, especially in a fast preheat to a high temperature. It is unfortunate that a process so noteworthy from the standpoint of uniformity of its physical effect, has shortcomings that cause non-uniformity.

The problem has been solved in some instances by rotating cylindrical preforms in an electrostatic field that is deliberately distorted to create heating conditions that give uniform surface heat and at the same time give 100 percent access to the surface for application of hot air.

Blown Plastics

From "Blown Molding Plastics" by James Bailey, Plax Corporation. Presented Feb. 7, 1945, Canadian section meeting, Society of the Plastics Industry.

The possibilities and details of three general methods of molding hollow articles such as bottles and containers by blowing, as glass is blown, were discussed by the author. The system used by Plax is a modified injection molding process. With it bottles have been made successfully from cellulose acetate, cellulose acetate butyrate, ethyl cellulose, polyethylene and polystyrene. Articles can also be made with air sealed within under pressure.

Plastic bottles and containers are not expected to replace glass except where

the considerably higher cost of plastic materials can be justified or the volume proportionately reduced. Where light weight, immunity to breakage, toughness, and artistic possibilities can be exploited, plastic containers made by blowing have good possibilities.

Effect of Plate Width

From "Fabrication Costs of Boilers, Tanks and Pressure Vessels as Affected by Plate Widths" by W. G. Theisinger, Lukens Steel Company. Presented in Dec. 1944, annual meeting, American Society of Mechanical Engineers.

Substantial savings can be made by fabricating single wide plates in preference to joining a number of narrower plates in the manufacture of boilers, tanks or pressure vessels. The author discussed first the theoretical relationships and possibilities and compared the number of manufacturing steps required with wide and narrow plates. Significant examples were cited with actual construction costs of pressure vessels and locomotive fireboxes and boilers in which single wide-plate construction is compared with multiplate fabrication.

After reviewing these factors, special materials were discussed. Savings in low-alloy steels were found to be less than those obtained with plain carbon steel and more in clad steels, stainless and non-ferrous materials. Useful tables were presented giving a comparative fabrication procedure and cost accounting for one-plate and two-plate construction, variation of cost with width of plate on locomotive fireboxes of various girths, sizes of sheared or flame-cut steel plates, and width extras.

Residual Stress in Plastics

From "Residual Stress in Formed Methacrylate Sheeting" by R. Richardson, Duplate Canada, Limited. Presented Feb. 7, 1945, Canadian section meeting, Society of the Plastics Industry.

Polariscope examination of a new part having higher than normal breakage in service showed that residual stress was present near small-radii bends. An examination of the forming method showed that the operator or method was not at fault. Alternate methods of forming did not indicate that the part in question could be produced with less residual stress. Further research showed that stress was being imposed on the part during installation, mainly at bolt holes. A canopy shape correction was recommended. Since this correction could not be made at once, the immediate solution was to increase the radii of curvature of the part.

Removal of Stress During Production

Attempts to anneal the part on the form were not successful. To be practical at all, annealing has to be done after forming. A number of laboratory heating cycles that would remove residual stress were worked out but never used on production because: design changes were practical; cycles required several days for completion and facilities were not available; cycle temperatures were dangerously near deforming temperatures; annealing after forming would have relatively little beneficial effects on stresses imposed by drilling, rabbiting and bolting the sheets to the forms. During this work it became even more apparent that these stresses not only existed during the drilling and other operations but were residual, remaining for some time after working as a potential source of breakage.

Types of Stress

Internal stresses, set up during forming or molding are visualized readily by a standard polariscope employing polaroid film. Such stresses can usually be removed by annealing at relatively high temperature with a slow cooling cycle. This temperature and cycle may cause deformation depending on the formulation of the material treated. The presence or absence of this type of stress is not indicated by surface etching.

Surface stresses cause crazing. While crazing is not completely a surface phenomena, these stresses are peculiarly related to the surface in that surface etching of the material discloses their presence or absence. Acetone is used for etching molded specimens and dichlorethylene for sheeting. These stresses are also peculiarly related to the surface in that annealing cycles for them do not require a long cooling period such as an internal condition would indicate.

Intermediate stresses are shown by both polariscope and surface etching. The annealing treatment in removing them is intermediate in time consumed and intensity required. An example is the work stress produced during and remaining after drilling a hole in either formed sheeting or molded in methacrylate.

These classifications will no doubt be criticised. It will be argued that the so-called surface stresses are not stresses at all but purely chemical arrangement of the surface or near-surface chains. But even if they are not true stresses they should be considered as such for practical purposes.

Cable Insulation

From "Some Aspects of the Application of Synthetic Rubbers and Resins in the Cable Industry" by Douglas Short, Canada Wire and Cable Company, Ltd. Presented Feb. 7, 1945, Canadian section meeting, Society of the Plastic Industry.

Synthetic plastics for electrical wire and cable insulation are usually extruded directly onto the wire. One of the first of the synthetic rubbers, Neoprene, has been in use for a number of years for outside coverings to give wire mechanical protection and flame, oil and sunlight resistance. Neoprene has relatively poor electrical insulating properties.

Buna S, fundamentally a hydro-carbon, can be compounded to make an electrical insulant almost the equal of vulcanized rubber compounds. Like Neoprene, it is also blended into compounds for sheathing, or jacketing for many types of cable. Common household cables, such as those for electric iron, lamps, vacuum cleaner, shaver, and radio can be satisfactorily covered with Buna S compounds.

Copolymer vinyl chloride and vinyl acetate resins, known by the trade names, Koroseal, Geon, and Vinylite, have found their widest application in cable coverings. Polyvinylchloride and the copolymers are powders in the natural state, produced from ethylene; and only after combining with suitable plasticizers are their latent rubber-like qualities developed. Although they are only fair insulants, their electrical characteristics are of a degree to warrant use as an alternative to vulcanized rubber compounds, particularly for field telephone cable and other essential requirements. They are immune to many conditions and reagents inimical to rubber compounds, and in this respect have proved successful as protective jackets.

Probably one of the most promising

synthetic plastics for cables is the recently discovered polyethylene, a solid wax-like material polymerized at high pressures from ethylene gas. Known also as Polythene, and Telcothene, it is a translucent pure hydrocarbon, having plastic properties, so that unlike the polyvinylchlorides it is not necessary to introduce plasticizing agents. Being a pure hydrocarbon, chemically analogous to paraffin wax, it possesses exceptional dielectric properties at all temperatures and frequencies, a characteristic that, along with its plasticity, makes it an outstanding cable insulating material. Its use so far has been confined to what are known as high and ultra-high frequency transmission line cables. In this field polyethylene, on a variety of special cables, has contributed to many striking radio developments of this war. Postwar applications of polyethylene insulants will be far reaching.

Arc Welding Progress

From "Modern Developments in the Use of Arc Welding" by W. J. Conley. Presented Jan. 23, 1945, annual meeting, American Institute of Electrical Engineering.

Wartime development of electrodes that can be handled with greater ease, of fitup and welding procedures that can be controlled more accurately, and of fixtures and handling equipment to prevent warpage and distortion, have resulted in jumping the rate of depositing weld metal from 1 to 4 lb. per hr. in manual welding.

In a study of methods for increasing the speed of welding and using less deposited metal it was found that as arc speed is increased more energy is available to melt the base metal. For example, a T-joint made with fillet welds at 5 in. per min. with a ¼-in. electrode and 300 amperes without fusion into the corners, is made by the new technique with the same size electrode, but with a faster slag coverage and having higher current capacity, at 12 in. per min. and 350 amperes so as to give fusion ⅛ in. beyond the corner. Joint strength was increased 25 percent while deposited metal and time were reduced 50 percent.

The same technique was then applied to butt joints. Using a square butt joint instead of a V-joint, deposited weld metal was reduced 50 percent and manhours 78 percent in welding ⅜-in. steel plates manually. Welding speed was increased from 2 to 9 in. per min.

In automatic welding the larger currents made possible much faster melting rates so that larger V-joints can be filled with a single pass. Square butt joints in plate 1¼ in. thick can be joined by two passes without excessive build-up. Speeds up to 120 in. per min. are possible in ⅛-in. sheet.

Discussions and Comments From Readers

CREDIT FOR X-RAY TIMBER

To the Editor:

On page 80 of the February 1945 issue of PRODUCT ENGINEERING you carry a story "Electronic Timer Gives Uniform X-Ray Exposures." You make the statement that this device was developed by the Westinghouse Electric & Manufacturing Company. This statement is not true. This device was developed by Dr. Hodges and Russell H. Morgan, Division of Roentgenology, The University of Chicago. To the best of my knowledge and belief the actual development and practical conclusion of this work was done at the University of Chicago, and credit should go to them for this development.

May I refer you to a report "U. S. Public Health, Vol. 58, No. 42, October 15, 1943, pages 1533-1541. The Automatic Control of Exposure in Photofluoregraphy, by Russell H. Morgan." This report covers the same description and details (essentially) as you cover in the current issues of Product Engineering.

—J. ROBIE ELLIOTT

EDITOR'S NOTE: The story as told Westinghouse contained the statement: "Use of the photoelectric cell to control exposures in photofluoregraphy was first undertaken by Dr. Paul C. Hodges and Dr. Russell E. Morgan at the University of Chicago." In editing, this statement was deleted. Doctors Hodges and Morgan engineered the first timer as a laboratory model. Westinghouse developed the commercial product, using the same principles.

DISCUSSION ON THERMAL EXPANSION OF CYLINDER

To the Editor:

In reviewing PRODUCT ENGINEERING of July 1944, I came across the comments by Carl P. Nachod, page 493, and Edward L. Rogers, page 494, on your Reference Book Sheet "Shrink Fit Calculator," PRODUCT ENGINEERING, January 1944, page 71. I notice that both have made an error in the fundamentals of the derivation of the expansion formula for the diameter of a cylinder. Their mistake lies in their attempt to derive this formula from the volumetric relationship.

First, I should like to point out that the diameter is a linear dimension, and therefore the expression for linear expansion, $L_f = L_i\ (1 + \alpha t)$, applies.

Furthermore, the formulas for both the quadratic and cubic expansions are approximate, their derivations being:

I. Area:

let A = area
L = length
W = width
α = coefficient of linear expansion
t = change in temperature

and the subscripts i and f designate initial and final measurements respectively.

Then (1) $A_i = L_i W_i$
(2) $A_f = L_f W_f$
and (3) $L_f = L_i (1 + \alpha t)$
(4) $W_f = W_i (1 + \alpha t)$
whence (5) $A_f = L_i W_i (1 + \alpha t)^2$
or (6) $A_f = A_i (1 + \alpha t)^2$
and since (7) $(1 + \alpha t)^2 = 1 + 2\alpha t + \alpha^2 t^2$
we have, by dropping $\alpha^2 t^2$ which is negligible,
(8) $A_f = A_i (1 + 2\alpha t)$
the generally accepted expansion formula of of an area.

II. Volume:

let V = volume
H = height, keeping other symbols as before.

Then (1) $V_i = L_i W_i H_i$
(2) $V_f = L_f W_f H_f$
and (3) $L_f = L_i (1 + \alpha t)$
(4) $W_f = W_i (1 + \alpha t)$
(5) $H_f = H_i (1 + \alpha t)$
whence (6) $V_f = L_i W_i H_i (1 + \alpha)^3$
or (7) $V_f = V_i (1 + \alpha t)^3$
and since (8) $(1 + \alpha t)^3 = 1 + 3\alpha t + 3\alpha^2 t^2 + \alpha^3 t^3$ we have by dropping $3\alpha^2 t^2 + \alpha^3 t^3$ which as before is negligible,
(9) $V_f = V_i (1 + 3\alpha t)$
the commonly accepted expression for volumetric expansion.

The final, simplified expression in each case will be recognized as the same value as that obtained by using the approximation differentiating process.

It is obvious that when reversing the procedure, that is, deriving the expression for the linear (or diametral) expansion, which is an absolute and fundamental concept, from either the quadratic or volumetric expresssions, both of which are derived approximations, an exact result will not be obtained. Hence the discrepancy that prevents the reconversion of the derived expression into the original by a reversal of the steps in the procedure.

The presence of a constant in the original expression, does not effect the result since it is retained throughout the derivation.

—JOACHIM I. WEINDLING

AMERICA WANTS PROSPERITY

A BOOK to be published early in April by the McGraw-Hill Book Company carries the provocative title "Prosperity: We Can Have It If We Want It." Its authors, Messrs. Shields and Woodward, state in vigorously challenging terms their conviction that the United States will emerge from war with human, material and technological resources adequate to provide a nation-wide standard of living unprecedented in world history. They present, too, their formulation of the several policies and procedures which must be followed by government, business, and labor if we are to realize our potential for a high and sustained prosperity unmarred by prolonged periods of severe unemployment and business stagnation such as have haunted our economic past.

The specific proposals set forth will elicit both enthusiastic acclaim and acrid dissent, for the book deals in far from gentle fashion with many of the currently fashionable panaceas for assuring prosperity by magic formula. It examines, and discards as effective guarantors of prosperity, whatever their individual merits upon other grounds, programs for public works, slum clearance, subsidizing of small business, foreign loans, social insurance, deficit government spending, redistribution of income, the numerous formulae for monetary management, repeal of the anti-trust laws, or any of the loosely-phrased admonitions that government should do nothing and allow everything to take its course untrammeled by controls of any kind.

On the positive side, the book urges clear recognition of the fact that prosperity, under a system of business enterprise, depends primarily upon the existence of competitive incentives that spur capital investment to provide better tools and equipment, that improve organization and technology to insure continuously increasing productivity per man-hour of work, and that enlarge markets by producing what the consumer wants at lower prices to the end that real incomes may be increased.

In short, prosperity depends upon profitable and expanding business and employment opportunity, so it becomes the part of enlightened government, business, agriculture and labor policy to promote those measures which will forward rather than retard the major aim of expanding production.

However great the room for dissent upon the adequacy, or the phrasing, of the specific recommendations it makes, the approach of this book has one virtue of solid merit. It attacks positively the problem of what steps should be taken to achieve and hold prosperity rather than merely devising a poultice to be applied when and if we run into a decline.

Virtually all responsible spokesmen for government, and for business, labor, and agricultural groups, are agreed upon the goal of prosperity. Moreover, they agree that, insofar as possible, it should be achieved through the effort of private enterprise, with government intervention utilized only as a last resort. But despite this unanimity, almost all public discussion of the problem has concentrated upon the nature, the extent, and the timing of such government expenditures as may be found necessary to combat deflation. Since upon this question there is far from general agreement, our procedure has created an exaggerated sense of divergence in a field in which, so far as fundamentals go, we all are in accord to quite an unusual degree.

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No confusion should be caused by the fact that the generally current phrase for prosperity is "full employment." The latter phrase merely states the goal in terms of human values, which are good terms in which to state any goal. What matters is that we generally are agreed as to what we mean when we say that we want prosperity or full employment. Not only do we know what we mean, but within very rough limits we can give dimension to our concepts. There are a few whose appraisals are somewhat lower, but most competent estimators set the goals for about 1950 at an average annual employment in civilian jobs of between 55 and 57 million persons, with a gross national product of between $185 and $200 billion measured at 1943 price levels. This contrasts with the 1944 level of non-military employed of 51½ million, and a gross output for the end of 1944 of over $200 billion. It assumes a reduction of the average workweek to 40 hours.

It will take some such levels as these to provide employment for those who seek work, with only sufficient "frictional" unemployment (those temporarily listed as unemployed because of the normal turnover between jobs) to afford reasonable labor-market flexibility to both workers and employers. The non-military employment figures are generally consistent with the officially stated postwar goal of jobs for 60 million workers, since the latter figure is generally understood to be an estimate of the *labor force,* which includes members of the armed services and an allowance for frictional unemployment.

There are a number of reasons why the estimates cannot be figured more closely, and why no one can be very confident even of the validity of the stated limits. The chief points of doubt in the employment estimates relate to how many withdrawals there are likely to be on the part of women, oldsters, and youngsters, who now are in the labor force to a number more than 6 millions beyond normal expectancy; how many men will be retained in the armed forces; and whether the

postwar frictional unemployment should be calculated as approximating the current 1 million or the 3 million so-listed in the prosperous year of 1929. Additional uncertainties cloud the estimates of gross national product. Notable among them is the fact that no one is sure of the war's effect upon man-hour productivity trends, in view of the fact that half of our current output has consisted of products that had no substantial counterpart in our peacetime price or production series.

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Nevertheless, despite such qualifications, it is fair to say that we do have a general conception of the magnitude of our postwar goals. Although they are well within our production potentials as demonstrated in this war, they are formidably beyond any previous record of peacetime achievement. Only the most sanguine optimism could lead one to expect that they will be achieved without concerted will, planning, and cooperative effort. Only blind recklessness could engender confidence that once attained they will automatically be held, let alone expanded in normally healthful growth.

If we were to follow past patterns, our war-built boom would, after a period of uncertain length, collapse into disastrous depression. The very magnitude of our recent growth would contribute to the depth and duration of the subsequent trough. Yet a fall even to the level of our previous peacetime-peak-year 1939, has been estimated by The Federal Reserve Board to imply unemployment for between 15 and 20 million persons. If human values have importance, that is something that must not be allowed to occur. If business values have importance, we must not tolerate again such losses as occurred from 1930 to 1933, when sales over the four year period were $128 billion less than would have been provided if the 1929 level had held, and corporate profits declined from more than $7 billions in 1929 to an average annual loss of $1 billion over the next four years. A repetition of these things cannot be tolerated—*if foresight and cooperative effort can prevent them.*

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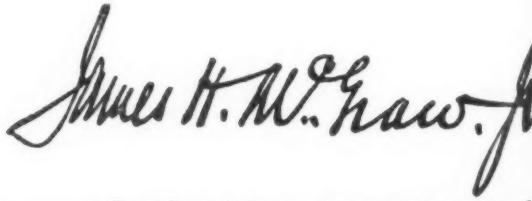
In January of this year Senator Murray introduced in the Senate a bill entitled "The Full Employment Act of 1945." It instructs the President to submit to Congress plans for eliminating both unemployment and inflation, including recommendations for correcting structural defects in the economic system. It provides for a Joint Congressional Committee to consider the proposals of the President, to take testimony from experts and the general public on these proposals or any others it may wish to consider, and after weighing all the facts to submit its findings to Congress. It provides for an advance budgeting of the constituent parts of a full-employment economy, and commits the Federal Government to provide, in advance, for sufficient expenditures (through private contractor channels) to make up for the gap between estimated private expenditures and the amount necessary to assure full employment.

By no stretch of the imagination can The Full Employment Bill, in its present form, be regarded as acceptable to business. Yet it may well present a test of whether or not American business can deal with problems in this area in a statesmanlike fashion. Such statesmanship will consist in demonstrating first, that the Bill is not acceptable because of deficiencies which preclude the possibility of its accomplishing the avowed purposes; and second, that business is able and anxious to offer constructive suggestions for remedying these deficiencies.

It is easy to point to weaknesses in the Bill. To mention only a few of major importance: The proposal to make advance Federal expenditures to compensate for estimated deficiencies in prospective private expenditures is completely impracticable. No one in the country can predict future trends with sufficient accuracy for this purpose; no one can tell what the constituent parts of a really high, *stable* peacetime budget should be, for in our boom-or-bust economy we have no stable pattern to project; no one can tell, within reasonable limits, how much the government should spend *in advance* to assure full employment. The Bill pronounces labor's right to work without defining commensurate responsibilities which it should exercise. It does not define the areas of proposed government expenditure in such a way as to allay business fears of government competition or the general public suspicion of leaf raking. Above all, the Murray Bill is defective in that, despite a somewhat vague pronouncement in favor of forwarding private business activity, it recommends a single specific designed to supplement such activity rather than stimulate it.

The very definition of certain of these faults suggests their remedies. But the positive task of stating how the Bill should be amended in order that it may have effective usefulness is far from simple. Yet it is enormously to the advantage of American business to undertake it. Fortunately, there is a representative group sponsored by industry, The Committee for Economic Development, which has for some time been working intensively upon the problem, and which is excellently equipped to offer sound and progressive advice. It should be used for this purpose.

American business cannot afford to take a negative attitude toward legislation in this field. Some legislation undoubtedly will pass, for the problem is one in which there is a grave government responsibility. But equally there is a comparably important responsibility upon all citizen groups. None of them has more to gain or lose from the rise or fall of prosperity than American business.



President, McGraw-Hill Publishing Co., Inc.

New Books

Production Engineering in the Aircraft Industry

A. B. Berghell. 307 *pages*, 5½ x 8¾ *in., blue clothboard covers. Published by McGraw-Hill Book Co., 330 W. 42nd St., New York* 18, *N. Y. Price* $3.

The forecast and control of costs in any mass-production industry is difficult, but it is especially so in the aircraft industry where method improvements are constantly being made and cost is a variable depending upon the number of airplanes being manufactured. The author presents an analysis of the problem describing the available standards upon which estimates can be based or upon which production can be controlled and refined. Considerable space is devoted to the use of statistical data and of log-log curves. Log-log learning curves are described and their use in the graphical determination of manufacturing costs is explained. The author has included many problems and provides answers to these in the back of the book.

Lubricants and Cutting Oils For Machine Tools

William G. Forbes. 90 *pages*, 5½ x 8½ *in., black clothboard covers. Published by John Wiley & Sons, Inc.*, 440 *Fourth Ave., New York* 16, *N. Y. Price* $1.50.

The purpose of this book is to explain the fundamental principles of lubrication in relation to metal cutting, to give practical information and to serve as a machine shop guide. The material has been extracted from the author's more detailed book on Lubrication of Industrial and Marine Machinery. The nine chapters in the book cover tests and specifications, greases, types of machine tools, lubrication of machine tools, metal cutting, composition, compounds and blends of cutting oils, application of cutting oils and skin infections.

Process Equipment Design

H. C. Hesse *and* J. H. Rushton. 580 *pages*, 5¾ x 9 *in., stiff black leatherette covers. Published by D. Van Nostrand Co., Inc.*, 250 *Fourth Ave., New York, N. Y. Price* $7.50.

Few engineers are required to make complete designs of process equipment used by the chemical industry. In order that chemical engineers can become acquainted with the overall design problem the authors include the fundamentals of mechanics, machine and structural elements, and economic and manufacturing considerations. This book is based upon five years of lecture and laboratory work with senior engineering students. Intended primarily as a college textbook or for graduate engineers who have not studied the elements of design, this book approaches the problems of design in the order of their increasing analytical complexity.

Arc Welding Engineering And Production Control

Walter J. Brooking, 350 *pages*, 5 x 8 *in., green clothboard covers. Published by McGraw-Hill Book Co., 330 W. 42nd St., New York* 18, *N. Y. Price* $4.

This text, dealing with control of arc-welded production, is intended to serve as a link between the elementary literature for training operators and the highly technical reports of developmental research, and to give a working knowledge of arc welding. The general factors affecting arc welding for production by a large user of this welding method are analyzed so that the reader will be able to apply them to the needs of other fields. The 18 chapters of the book deal with the general problems and factors to be considered in using the method and with specifications, engineering control, material control, costs, flame cutting, fitting, jigs and fixtures, inspection, machining, operator training, equipment, direct and alternating current welding, electrodes, maintenance and repair welding, and how to keep informed on latest developments in welding.

Control of Electric Motors

Paisley B. Harwood. 479 *pages*, 5½x8½ *in., blue clothboard covers. Published by John Wiley & Sons., Inc.*, 440 *Fourth Ave., New York* 16, *N. Y. Price* $5.

A new second edition of this book meets the request to include more information about synchronous motor and variable-voltage control. This information is included in two additional chapters. New tables are included to give ratings of motors and controllers and all illustrations have been revised to conform with latest practice. The author has radically changed the arrangement of this book and controllers are now described in chapters covering the type of motor to which they apply. The volume presents the characteristics of various motor types and explains how these characteristics are used for control purposes. The design, construction and operating characteristics of controllers and control devices are described as well as many of the problems which are frequently encountered.

The Modern Gas Turbine

R. Tom Sawyer. 216 *pages*, 6x9 *in., green clothboard covers. Published by Prentice-Hall, Inc.*, 70 *Fifth Ave., New York, N. Y. Price* $4.

The author presents an authoritative treatise on the gas turbine from its conception to its present stage of development. The text is fundamental and presents sinple mathematical calculations in a form that is readily understandable. The author explains and describes many of the early inventions and history of the gas turbine. Combustion gas turbine calculations and efficiencies are presented in a chapter written by Ronald B. Smith. The uses of the gas turbine in industry, marine service and the turbine locomotive are each described in a separate chapter. Another chapter is devoted to the gas turbine as an aircraft prime mover and included is a history of jet propulsion.

Bulletin

Leaf Springs

S.A.E. Special Publications Dept., 29 West 39th St., New York 18, *N. Y. Copies are available to S.A.E. members at* $1 *each, to non-members at* $2 *each, postpaid.*

"Manual on Design and Application of Leaf Springs," prepared for the U. S. Army Ordnance Department by the War Engineering Board of the Society of Automotive Engineers, has been made available for use by industry.

The Manual, comprising 89 pages, presents 44 figures, four tables, and numerous detailed calculations, and includes data on materials, surface finishes, design elements and calculations, interleaf frictions, protective coatings, and manufacturing conditions. Three pages are devoted to nomenclature and specifications, five pages to requirements drawings and specifications.

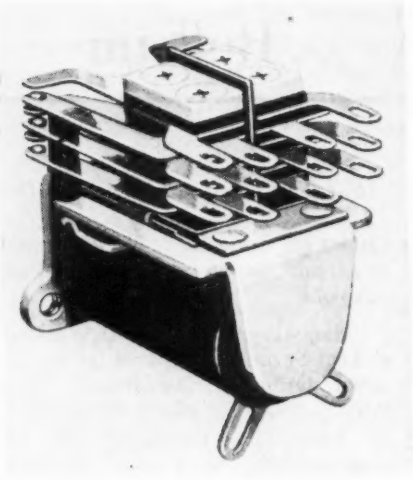
Purpose of the Manual is to facilitate calculation of space requirements for springs and attachments, determination of elastic and geometric properties. It was prepared by Leaf Spring Subcommittee composed of 16 engineers representing vehicle and spring manufacturers and suppliers aided by seven military consultants.

NEW MATERIALS AND PARTS

Lightweight Relay

R-B-M Manufacturing Co., Logansport, Ind.

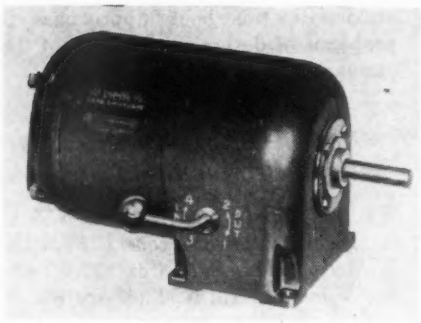
Weighing only 1¾ ounces the specifications include 6 normally open contacts; rating, 3 amp d.c. non-inductive. Available in other arrangements or normally open and normally closed contacts. Vibration resistance up to 10 g's at 40,000 feet; temperature ranges, — 65 deg. C. to + 85 deg. C. Approximate dimensions, 2 1/16 in. long, 1½ in. high, ⅞ in. wide. Design and construction meet Signal Corps requirements for resistance to humidity, salt spray, and fungus. Magnet coil bobbin is of high-impact, specially molded phenolic material, resistant to electrolysis, and capable of withstanding severe humidity. The entire contact pile-up assembly is baked 100 hours at 230 deg. F. and after baking all screws are re-tightened, contacts aligned and pointed. The type of relay also available with heavy duty contacts rated at 10 amps. 28 volts d.c. non-inductive.



Four-Speed Drive

The Lima Electric Motor Co., Lima, Ohio.

This unit is designed for machine tools and other equipment requiring motor capacities of 1 hp. or less. Weighing only 85 lb., the unit has an overall length of only 18 in. including the shaft extension; the overall width, including terminal box and shifting lever is 12 in., while the overall height is only 9 in. The unit is rated at ½ and ¾ hp. at 1,200 r.p.m. and 1 hp. at 1,800 r.p.m. Identified as Type *R*, it is designed for continuous operation, with ample overload capacity. A Lima semi-enclosed, drip-proof, ball-bearing motor of either 2 or 3 phase, 50 or 60 cycle, 220, 440 or 550 volts is furnished as a standard integral part of this unit. Type *R* is reversible in all speeds with the use of a reversing drum control. Single-phase units in above sizes to be available when conditions permit. The speed ratios of Type *R* are 1 to 1, 1.33 to 1, 2 to 1 and 4 to 1. Shifting is done by means of a small lever which can be extended to any convenient position as required.



Drop-Forging Alloy

Wyndale Mfg. Corp., 1203 Cornell Ave., Indianapolis, Ind.

Supplied in the form of drop forgings or open-frame hammer forgings, Wyndaloy-Chace 720 is a non-ferrous non-magnetic alloy of high strength, high wear resistance, high electrical restisitivity and good corrosion resistance. Special heat treatments will produce forgings with a hardness of 400-500 Brinell, tensile strength values exceeding 200,000 lb. per sq. in. and yield point values exceeding 120,000 lb. per sq. in. Elastic properties and ductility are also good. The alloy has a modulus of elasticity of approximately 20 x 10^6 lb. per sq. in. Its coefficient of expansion is about the same as that of copper. It has a silvery color and will take a high polish.

Rubber Cement

The B. F. Goodrich Co., Akron, Ohio.

Plastilock 500 is a non-thermoplastic, water and aromatic oil-resistant adhesive for bonding metals, wood, plastics and ceramic material to themselves or to each other. In using Plastilock 500 the company advises that best results are gained by applying heat with pressure, although heating alone will give some degree of adhesion. Purpose of the pressure is to obtain good surface contact. The new adhesive, used for metal-to-metal bonding, has shown a shear strength of 3,250 lb. per sq. in. Tension strengths of 4,000 lb. per sq. in. have been reached. Tests made after the bonding of wood and plastic to aluminum, which presents extremely difficult problems of adhesion to other materials have resulted in the wood and plastic being torn because the strength of the bond was greater than that of these materials.

Axial-Flow Fan Units

Dynamic Air Engineering, Inc., 1619 S. Alameda, Los Angeles 11, Calif.

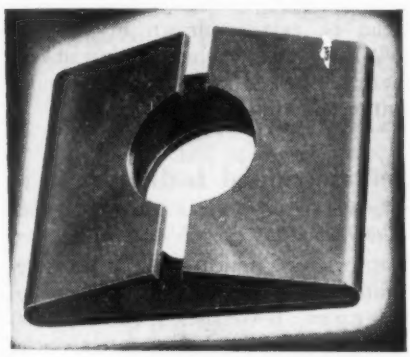
Two high-efficiency axial-flow fan units have diameters of 60 in. and 2 in., respectively. The 60-in. low-pressure propeller driven with a 10-hp., 1,150 r.p.m. motor delivers approximately 60,000 cu. ft. per min. free air and 5,000 cu. ft. per min. at ½-in. static pressures. The 2-in. propeller has been developed for a complete fan unit to be powered by a motor of approximately 0.002 hp. and

will deliver 30 cu. ft. per min. at 0.30 in. static pressure. It was originally engineered for cooling modulators in aircraft electronic equipment. The fans are built in both single-stage and multi-stage varieties. When multi-stage assemblies are built, guide vanes or contra vanes are employed to straighten the air stream between the various stages.

Spring-Tension Fastener

Adel Precision Products Corp., Burbank Calif.

Called Stalock Push-on, a spring-steel, one-piece, push-on fastener for threadless studs of metal or plastic is a companion piece to the recently announced Stalock nut. Furnished in standard sizes for studs or rivets with diameters of

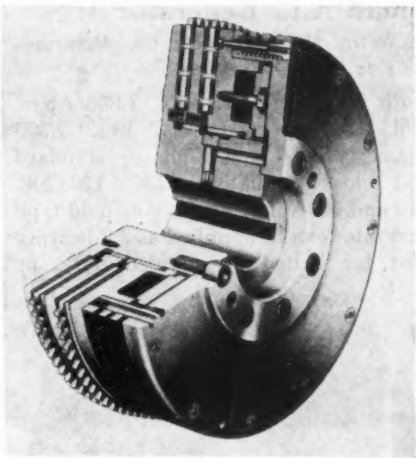


3/32, 1/8, 5/32, 3/16 and 1/4 in., with special sizes made to order, the fastener features light weight and speed of assembly. Over 1,600 lb. has been supported with a Stalock Push-on that was seated with finger pressure on a 16-in. cold-rolled stud. The fastener is stamped from a strip of sheet metal with ends bent back to form two opposed wings or tongues. It is then austempered for resiliency. The base has an aperture through which the stud is extended and as the fastener is pushed down on the stud, the tongues create an outward bow in the base which provides a constant biting or locking contact with the stud with a circular engagement. As tension increases, spring action of the bow in the base is intensified to produce even greater locking action without losing the inherent spring tension. For unseating a screwdriver is inserted between the base and the part it fastens to provide lifting power that will release the bit.

Clutch

Twin Disc Clutch Co., Racine, Wis.

The Twin Disc Model *P* air-actuated clutch is manufactured in a wide range of sizes, from 14 in. to 36 in. and

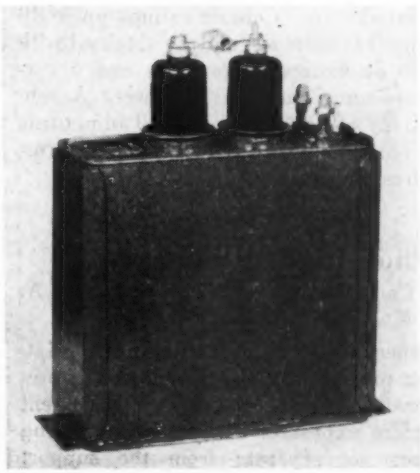


capacities, 65 to 895 hp. It operates by remote control without a complicated linkage system. Any amount of air pressure, within limits, can be applied to the friction plates to provide either slow or fast engagement. Its few moving parts assure easy maintenance.

Parallel-Plate Capacitors

General Electric Co., Schenectady 5, N. Y.

Designed for use in the resonant or "tank" circuit of high-frequency electronic oscillators a line of high-frequency, parallel-plate capacitors is connected in parallel with an inductance coil to constitute the resonant circuit which determines the frequency of the oscillator. In this application the capacitors are operated at relatively high voltages and can carry heavy currents continuously at frequencies up to several megacycles. Features are low losses at high frequencies; uniformly high dielectric strength; high current rating per unit volume; and convenient mounting and connection facilities. The units are available in standard ratings ranging from 2,000 volts, 0.025 microfarads to

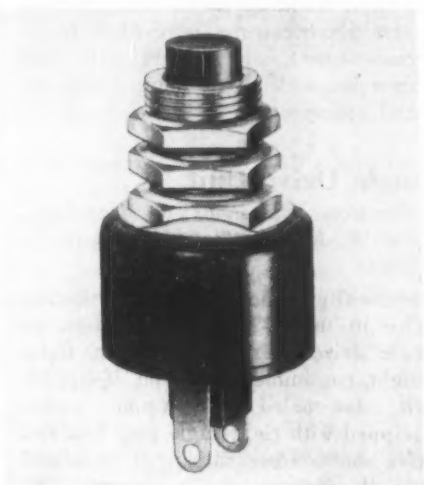


9,000 volts, 0.0056 microfarads. A synthetic dielectric liquid used is especially adapted for high-frequency applications. hermetically sealed joints, the sides of Constructed of non-magnetic metal with the case are sufficiently flexible to take care of liquid expansion caused by temperature changes. The capacitor is water cooled.

Snap-Action Switch

Grayhill, One No. Pulaski Road, Chicago, Ill.

The body of the switch measures only 7/8 in. in diameter by 1 7/8 in. high, measured from the top of the push button to the end of the solder lugs. The switch is mounted by a 3/8-in. bushing. 1/16 in. long and held securely by two mounting nuts. The contacts are of



silver overlay on phosphor bronze, and carry a current rating of 10 amperes at 115 volts a.c., and 2 amperes at 115 volts d.c. The total contact gap which breaks the circuit is 0.080 in. Contact pressure is approximately 35 grams and movement of the push button is only 0.0625 in. The normally open switch is indicated by a red push button, and a black push button indicates a normally closed switch.

Water-Resistant Adhesives

Paisley Products, Inc., 1770 Canalport Ave., Chicago 16, Ill.

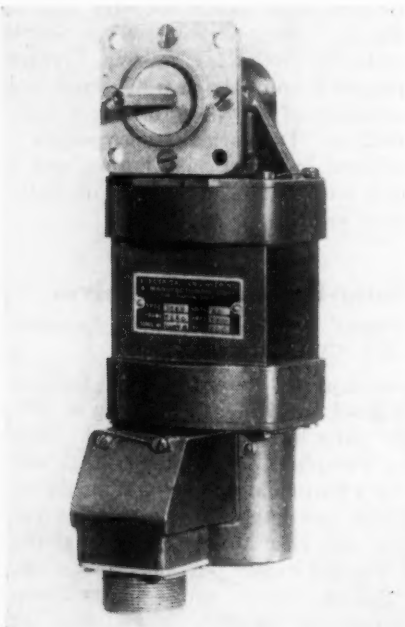
Four improved water-resistant adhesives designed for overseas packaging of military parts have been announced. Each has individual characteristics that suit it for a particular operation in the manufacture and final sealing of waterproof bags and case liners, and the gluing of V-board export box flaps. No. 3130, a reclaim rubber and resin emulsion with retack features, is designed for

quick bonding of case liner and waterproof bag stocks. No. 4016 is an asphalt and rubber emulsion, with retack features, for hand-brush application to large case liners and bags. It is medium fast setting. No. 676 is a vinyl-polymer emulsion for fast hand or machine sealing of V-boxes, small cartons, case liners and bags. No. 688, a vinyl polymer-starch adhesive, is for hand-brush sealing of V-board cartons and cases where good suction is necessary and final drying is accomplished under pressure. These adhesives are non-flammable and free from objectionable odors. They permit fast sealing because they can be water diluted to spread freely and evenly without brush drag. When used on asphalt laminated and impregnated papers and V-board, the emulsion penetrates the paper fibres and releases the resin film as the water insoluble bonding agent. The final adhesive film when dry is resistant to extremes of heat, cold, humidity and water immersion with a safe margin over the usual specification tests.

Angle Drive Unit

Electrical Engineering & Mfg. Corp., 4606 W. Jefferson Blvd., Los Angeles 16, Calif.

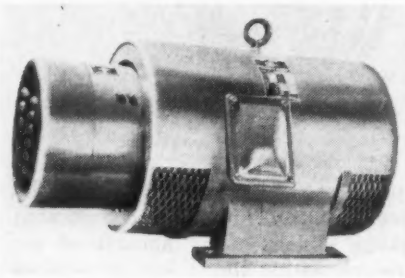
Specifically designed for cabin-heater drive in the A-26 attack bomber, an angle drive unit consists of a lightweight, continuous-duty type, ½-hp. 28-volt, fan-cooled 7,000-r.p.m. motor equipped with right-angle gear box and drive shaft. Gear ratio is 1 to 1 and over-all efficiency is 70 percent. The unit is engineered for restricted spaces in existing airframe structures.



Small A.C. Generator

Electric Machinery Mfg. Co., Minneapolis 13, Minn.

Built in ratings 6.25 kva., 1,800 r.p.m. and 1,200 r.p.m. to 18.7 kva., 1,800 r.p.m.; single- and 3-phase; standard and close regulation; 120, 120/208, 240 and 600 volts; a revolving-field type generator can be supplied as a 2-bearing unit for belted or coupled duty, or



single-bearing for close coupling to driving engine. Drip-proof generator and exciter construction is standard. The generator is built to withstand heavy-duty service on stationary or portable power units. It has enclosed ball bearings, cartridge-type bearings with sealed lubrication and high-torque dampers.

Snap-Action Relay

Struthers-Dunn, Inc., 1321 Arch St., Philadelphia 7, Pa.

All parts are readily accessible and sensitivity can be easily adjusted in the redesign Type 79XAX snap-action relay. Full normally-closed and open contact pressures are assured by snap action. The armature almost completes its travel in either direction before the contacts snap into the new position. The standard adjustment using 60 amp. turns in the coil at approximately 0.02 watt results in contact pressures of 5 grams with contacts rated 5 amp., 115 volts a.c.; or 0.5 amp., 115 volts d.c., noninductive. Contact ratings up to 10 amp. 115 volts a.c. may be obtained with 100 or more ampere turns and a corresponding increase in power. A sensitivity of 0.005 watts with 30 amp. turns is obtainable with reduced contact pressures and ratings.

Photo-Stencil Film

Craftint Mfg. Co., 210 St. Clair Ave., N. W., Cleveland, Ohio.

Especially for use in silk-screen printing processes, Photo-Stencil film is presensitized and requires no treatment before exposure. The sensitive coating does not separate from the support at low humidity conditions or become tacky at high humidity. It is protected from finger marks, scratches, dust and other damage by a thin cover film which also absorbs actinic light and serves as an anti-halation backing during exposures.

Acid-Proof Glass

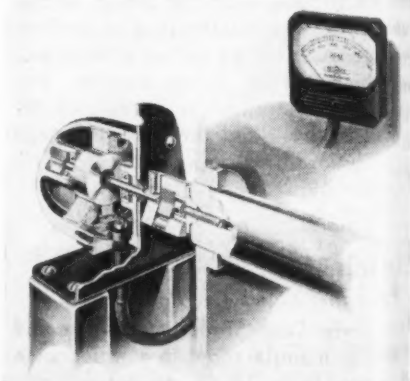
American Optical Co., Southbridge, Mass.

The discovery of a new glass of a special composition which withstands highly corrosive hydrofluoric acid, is expected to simplify the handling of that acid. The new glass does not contain sand, its major ingredients being phosphorus pentoxide. In spite of the great affinity of P_2O_5 for water the new material is less soluble in water than ordinary glass. Melting and working properties resemble those of ordinary glass closely, it can be cast or drawn into sheets, blown, ground, polished, tempered and otherwise worked without special equipment or techniques.

Electric Speed Indicator

The Reliance Electric & Engineering Co., Cleveland, Ohio.

Electric speed indicator gives accurate readings of speeds from 100 r.p.m. to 5,000 r.p.m. It consists of two separate parts. The pickup, a miniature six-pole alternator with a permanent magnet rotor, is mounted on the shaft whose speed is to be measured. A permanent magnet, moving-coil type indicator meters the pick-up output on a 3¾ in. scale which covers 95 deg. of arc. Length of leads connecting the units does not affect accuracy, and the indicator may be located at a considerable distance from the pick-up unit. The indicator is not affected by other magnetic material, and there is no loss of accuracy due to length of service. Instantaneous and continuous speed indication is independent of the direction of rotation of the shaft, reading up to 1,500; 2,000; 2,500; 3,000 or 5,000 r.p.m., and special



scales are available. Pick-up windings are stationary; there are no commutators or slip rings. No conduits are required.

Phenolic-Resorcinal Resin Glue

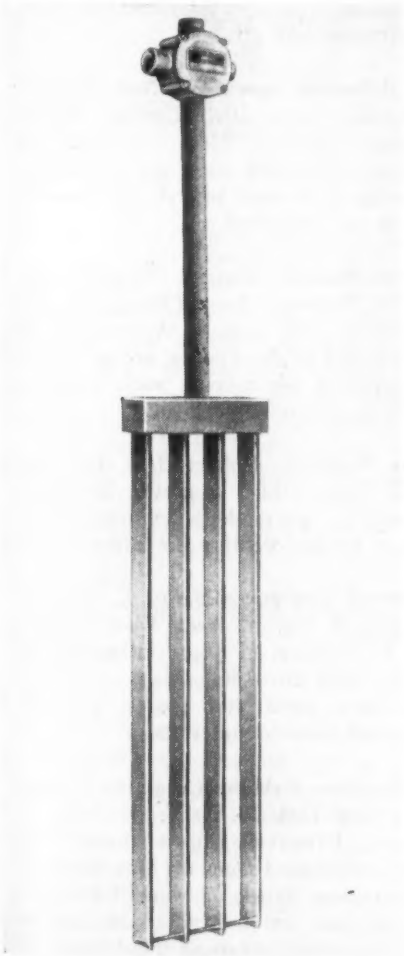
Bakelite Corp., 30 E. 42nd St., New York 17, N. Y.

Maximum water resistance for exterior plywood applications is a feature of XC-17613 phenolic-resorcinal cold-setting resin glue. Specifically developed as a cold-setting phenolic-resin glue for lamination of heavy lumber, beams, arches and ships' timbers the adhesive is also used for plywood glider fuselages, aircraft and marine construction and meets Army Air Forces Specification 14124.

Immersion Heater

Edwin L. Wiegand Co., 7500 Thomas Blvd., Pittsburgh 8, Pa.

For heating alkali cleaning solutions a Chromalox electric immersion heater is particularly suited for deep, vertical tanks where installation space is limited. A special cover prevents spill-

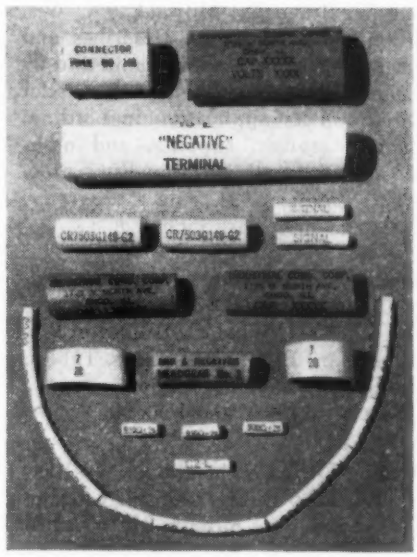


overs and fumes from reaching terminal connections. The 27½-in. seamless-steel-sheath Chromalox elements terminate in a steel housing with steel riser ending in a vapor-tight condulet cover. The riser length can be varied to meet tank requirements. Known as Type CHS, the heater is rated at 230-240 volts, 5 kw. All joints are welded.

Extruded Wire Markers

William Brand & Co., 276 Fourth Ave., New York 10, N. Y.

Installed in a slip-on assembly operation, Turbo Markers are intended for wire identification. They are made of extruded vinyl plastic and symbols are

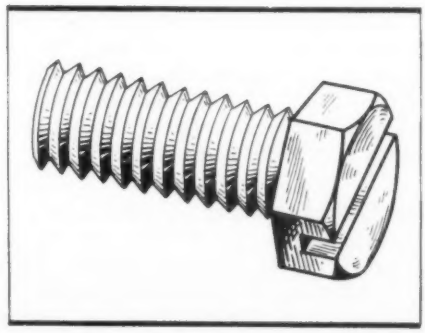


indelibly imprinted. These markers are available in all colors, as well as transparent, and in any diameter or length. Imprinting can be placed wherever desired, circumferentially or longitudinally.

Slotted Hex-Head Screw

Manufacturers Screw Products, J-210 W. Hubbard St., Chicago 10, Ill.

Machine and set screws with slotted heads for application by wrench or screw driver are called Hex-Scru. They

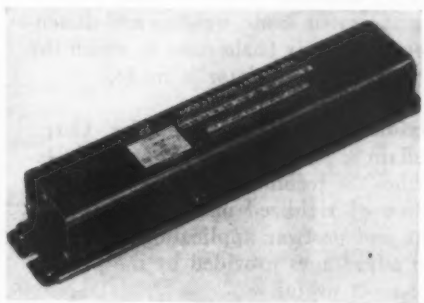


are made in lengths from ¼ to 1½ in.; diameters Nos. 6, 8, 10 and 12; coarse or fine thread by cold forging and have minimum internal stress and strain. Thread points are machine chamfered for easy starting and heads are trimmed to close tolerances.

Cold-Cathode Transformer

Sola Electric Co., 2525 Clybourn Ave., Chicago 14, Ill.

For the operation of two standard 8-ft. 20- or 25-mm. fluorescent lamps with gas pressures ranging from 3 to 7 mm. of mercury, a 900-volt cold-cathode

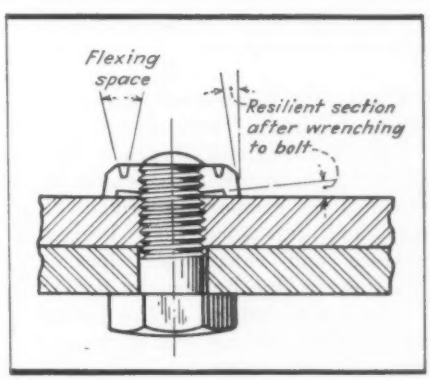


transformer is offered. Although designed for standard lamps it can also be used with special lamps of comparable lengths and diameters. Failure of one lamp does not affect operation of the other. Outlet box has five knock-outs to permit leads to be brought in from top, bottom, end or sides.

Lock Nut

National Screw & Mfg. Co., 2440 E. 75th St., Cleveland 4, Ohio.

Tightening develops a spring or flexing action to provide locking in a recently announced lock nut. A groove in the top



of the nut and an undercut in its base reduce the thickness to provide the spring action. This causes a constant pressure on the upper side of the nut thread and the lower side of the bolt thread, reducing the possibility of loosening under vibration.

Manufacturers' Publications

High Frequency Fittings — American Phenolic Corp., 1830 S. 54th Ave., Chicago 50, Ill. Catalog, Section "D", 8 pages. Describes 26 different types of RG cables and also many companion high frequency connectors for U.H.F. and electronic applications.

Vibration Control Unit—The Korfund Co. Inc., 48-15 Thirty Second Place, Long Island City 1, N. Y. Bulletin, 4 pages. Contains complete data regarding the rated loads, weights and dimensions in the six basic sizes in which the type SL Vibro-Isolator is made.

Rigidized Metals — Rigid-Tex Corp., Buffalo 3, N. Y. Bulletin, 16 pages. Describes the technique used in the preparation of rigidized metals, and typical war and postwar applications in which the advantages provided by the process are most useful.

Rolled Threads — Rolled Thread Die Co., Department PE, 237 Chandler St., Worcester 2, Mass. Booklet, 82 pages. The revised edition of the "RTD Thread Rolling Hand Book" covers the thread-rolling process in greater detail, and treats with cylindrical-die rolling as well as flat-die rolling. Requests for this booklet must be made on company letterhead.

Insulating Varnish—John C. Dolph Co., Newark 5, N. J. Booklet, 56 pages. Contains tables, charts and articles, all compiled for the purpose of providing an approach to insulating varnish problems, such as the selection of insulating varnishes and compounds, thinning of insulating varnishes, etc.

Electrical Test Equipment—Industrial Instruments, Inc., 17 Pollock Ave., Jersey City, N. J. Bulletin, 16 pages. Electrical test instruments discusses the direct-indicating comparison bridge, capacity and resistance limit bridges, resistance and capacitance decades, Wheatstone bridge, voltage breakdown testers and test fixtures, Kelvin bridge, megohm bridge and megohm meter, and conductivity apparatus.

Thermostatic Control — Westinghouse Electric & Manufacturing Co., P.O. Box 868, Pittsburgh 30, Pa. Pamphlet, 20 pages. For safe, accurate, automatic control of temperatures up to 650 deg. F., seven types of bi-metal thermostats to fill a wide range of applications are described. Tables permit easy selection; and cross-sections, curves and drawings illustrate operation and proper mounting of units.

Fasteners—Camloc Fastener Corp., 420 Lexington Ave., New York 17, N. Y., or 5410 Wilshire Boulevard, Los Angeles 36, Calif. Service Manual No. 44C, 8 pages. Describes the various service operations of the Camloc Fastener 4002 Series.

Chain Belts — Chain belt Company, 1600 W. Bruce St., Milwaukee 4, Wis. Bulletin 464, 16 pages. Describes and illustrates Rex Table Top chain and its design features in detail; the booklet also shows its application in bottling, labeling, sealing, capping, and other package or small part handling processes. Engineering data, diagrams, charts and prices are included.

Welding Information — Mir-O-Col Alloy Co., 2416-64 E. 53rd St., Los Angeles 11, Cal. "Welder's Guide to Successful Hard-Facing." 31 pages. Tables, information, and illustrations on the subject of welding and brazing.

Flexible Fitting—The Imperial Brass Mfg. Co., 1200 W. Harrison St., Chicago 7, Ill. Engineering Bulletin 34, 16 pages. The Imperial Flex Fitting makes a joint which permits the tube to flex, described and data given.

Production Control — The McCaskey Register Co., Alliance, Ohio. Eight flow charts illustrate how various elements of production control are provided by visualizing factory forms already in use in most plants.

Stainless Steels—Crucible Steel Company of America, 405 Lexington Ave., New York 17, N. Y. Folder. Properties of various types of stainless steels are listed.

Springs—Railway Steel-Spring Div., American Locomotive Co., 30 Church St., New York 7, N. Y. Bulletin 5001, 12 pages. Correct design of industrial springs is covered in detail.

Time-Cycle Controller—Taylor Instrument Companies, P. O. Box 110, Rochester 1, N. Y. Catalog 98154, 12 pages. Details of advantages and applications of the Flex-O-Timer for precise timing of the sequence and duration of operations involving temperature, pressure, humidity or combinations of these are presented.

Plastics—Eclipse Moulded Products Co., 5151 N. 32nd St., Milwaukee 9, Wis. Guide Book, 48 pages. Comprehensive survey of plastics is presented, including a graphic presentation of comparative properties, to serve as a guide for the proper application of various types of plastic materials.

Vibration Measurement—General Electric Co., Schenectady, N. Y. Bulletin GEA-4140, 8 pages. Dial-type and light-beam-type indicator for measuring displacement, and the velocity meter for measuring displacement or velocity of vibration are described.

Brake Intensifier—Pesco Products Co., 11610 Euclid Ave., Cleveland 6, Ohio. Folder, 4 pages. Describes and shows advantages of Univac, a device that converts engine manifold vacuum into hydraulic pressure for application to the braking system.

Air Control—Smallpiece, Ltd., 140 Elliott St., Beverly, Mass. Bulletin, 2 pages. Gives features of Marton Type S.109 air control unit which combines pressure regulator, gage, control valve, lubricator and strainer.

Ball-Bearing Screw and Nut—Saginaw Steering Gear Div., General Motors Corp., Saginaw, Mich. Bulletin, 24 pages. Features of a screw and nut having a formed helical ball race in each are described.

Reproduction—Charles Bruning Co., 4700 Montrose Ave., Chicago 41, Ill. Bulletin, 28 pages. Advantages of black-and-white printing are given and equipment for making such prints is illustrated and described.

Arc Welding—Hobart Bros. Co., Box 672, Troy, Ohio. Bulletin, 24 pages. Numerous common faults found in designs for arc welding are illustrated.

Pressed Ceramics—Henry L. Crowley & Co., 1 Central Ave., West Orange, N. J. Catalog, 44 pages. Illustrates in detail and gives dimensions of various standard parts and pieces made of pressed ceramic materials.

Adhesives—Bakelite Corp., 30 E. 42nd St., New York 17, N. Y. Bulletin, 12 pages. Urea-resin glues for wood bonding are covered from the standpoint of advantages, types of work for which these glues are best fitted and equipment required for using them.

Stresses in Flywheel Spokes and Rim

MERHYLE F. SPOTTS
Northwestern Technological Institute

THE RIM of a flywheel is unable to expand freely under the action of centrifugal forces caused by rotation, because of the restraining action of the spokes. In addition to tangential tensile forces, there are bending moments which act on the rim. The maximum value of the bending moment and tensile force occurs at a spoke.

Equations are given in the accompanying table for calculating the tangential tensile force F in the rim, the tensile force F_1 in the spoke, and the bending moment M acting on the rim at a spoke juncture. The symbols used in the Table and in Fig. 1 are

w = weight of rim per in. of circumference, lb.
r = radius to center of gravity of rim cross-section, in.
N = speed of rotation, r.p.m.
h = depth of rim, in.
b = width of rim, in.
A = bh = area of rim cross-section, sq. in.
A_1 = area of spoke cross-section, sq. in.
F_c = centrifugal force per in. of rim, lb. per in.
H = a numerical value which depends upon the proportions of the flywheel

Values of H for different r/h and A/A_1 ratios can be found by the expressions given in the Table, or can be taken from the curves of Fig. 2 (next page) when the flywheel has 6 spokes.

Unit stress in spoke caused by tensile force F_1 is F_1 divided by A_1, the area of spoke.

Unit stress in rim caused by tangential force F is F divided by A, the area of rim.

Stress S_m in the rim caused by bending moment is

$$S_m = \frac{6\,M}{bh^2}$$

Resultant tensile stress in the rim is the sum of the stress caused by F and the stress caused by M. Stress concentration effects are also present at the junction of rim and spoke.

The equations given are based on the assumption that rotation is uniform. Sudden accelerations as well as belt tensions may cause additional bending stresses in rim and spokes.

Equations for Forces and Moments in Flywheel Spokes and Rim

	H	F_1	F	M
4 spokes	$\dfrac{0.667}{0.0730\,(r/h)^2+0.643+A/A_1}$	$\dfrac{wr^2N^2}{35,200}\times H$	$\dfrac{wr^2N^2}{35,200}\,(1-0.500\,H)$	$0.1366\,F_1r$
6 spokes	$\dfrac{0.667}{0.0203\,(r/h)^2+0.957+A/A_1}$	$\dfrac{wr^2N^2}{35,000}\times H$	$\dfrac{wr^2N^2}{35,200}\,(1-0.866\,H)$	$0.0889\,F_1r$
8 spokes	$\dfrac{0.667}{0.0091\,(r/h)^2+1.274+A/A_1}$	$\dfrac{wr^2N^2}{35,200}\times H$	$\dfrac{wr^2N^2}{35,200}\,(1-1.207\,H)$	$0.0662\,F_1r$

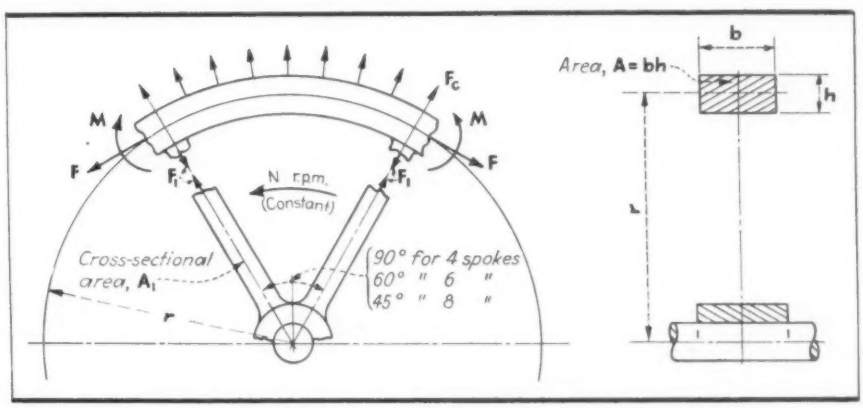


Fig. 1—Forces and moments acting on segment of flywheel.

EXAMPLE: Find the stresses in a cast iron flywheel rotating uniformly having 6 spokes, where

N = 600 r.p.m. h = 4 in.
r = 36 in. A = 48 sq. in.
b = 12 in. A_1 = 10 sq. in.

Solution: $r/h = 9$ $A/A_1 = 4.8$

$$H = \frac{0.667}{0.0203\times 81+0.957+4.8} = 0.0901$$

This value for H can also be obtained from Fig. 2.

w = $0.256 \times 12 \times 4 = 12.29$ lb. per in. of rim.

$$F_1 = \frac{12.29\times 36^2\times 600^2}{35,200}\times 0.0901$$

$= 162,900 \times 0.0901 = 14,680$ lb.

Tensile stress S_1 in spoke

$$S_1 = \frac{14,680}{10} = 1,468 \text{ lb. per sq. in.}$$

F = $162,900\ (1-0.866\times 0.0901)$
$= 150,200$ lb.

Tensile stress S in rim

$$S = \frac{150,200}{12\times 4} = 3,130 \text{ lb. per sq. in.}$$

M = $0.0889\times 14,680\times 36 = 46,980$ in. lb.

Bending stress S_m in rim

$$S_m = \frac{6M}{bh^2} = \frac{6\times 46,980}{12\times 16}$$

$= 1,470$ lb. per sq. in.

Resultant stress in rim
$S+S_m = 3,130+1,470 = 4,600$ lb. per sq. in.

Suppose the spokes were not present and the rim could expand freely under the influence of centrifugal force. The

centrifugal force per inch of rim is

$$F_c = \frac{wrN^2}{35,200} = \frac{12.29 \times 36 \times 600^2}{35,200}$$

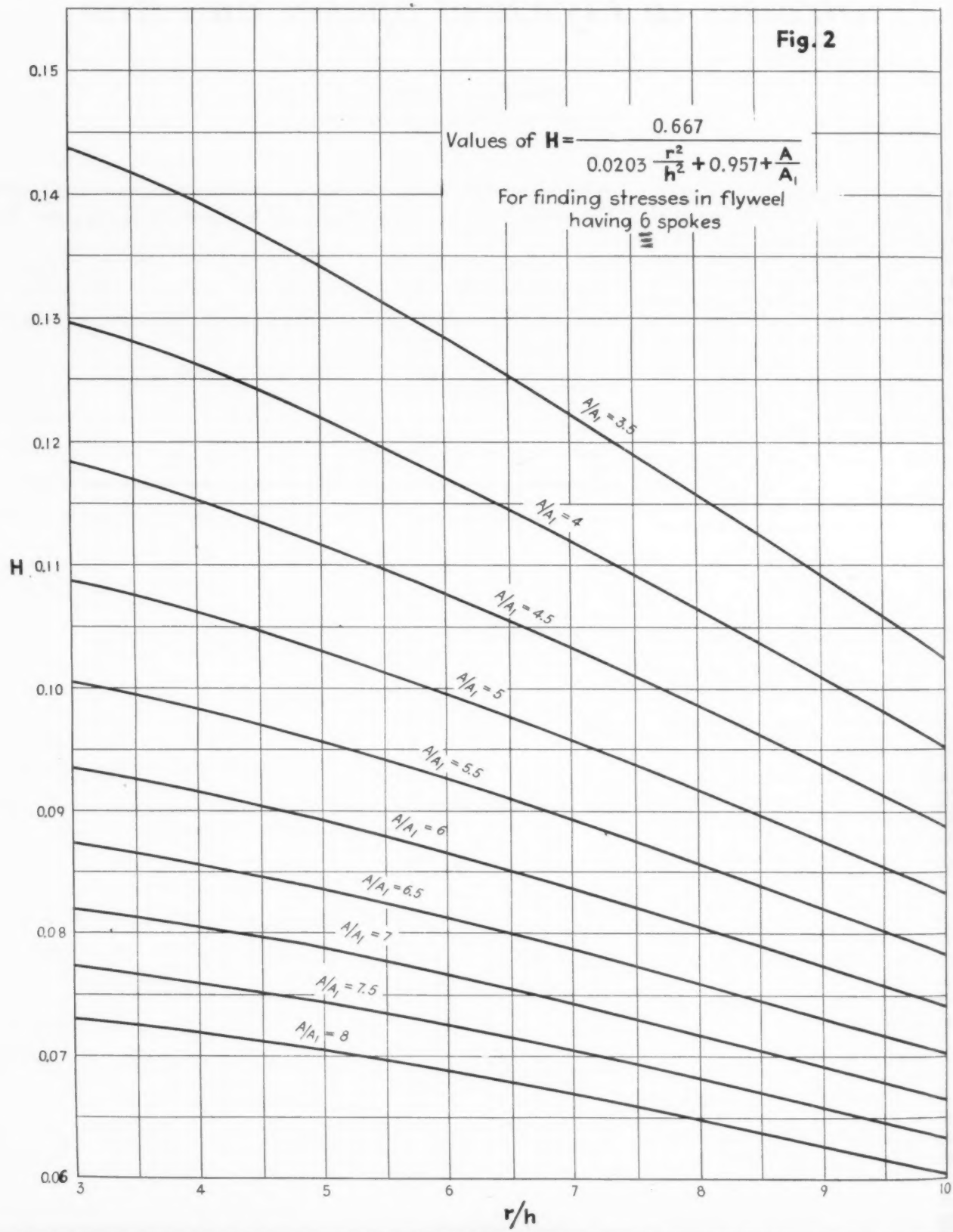
$$= 45,240 \text{ lb. per in.}$$

and the tensile stress in rim would be

$$\frac{45,240 \times 36}{48} = 3,390 \text{ lb. per sq. in.}$$

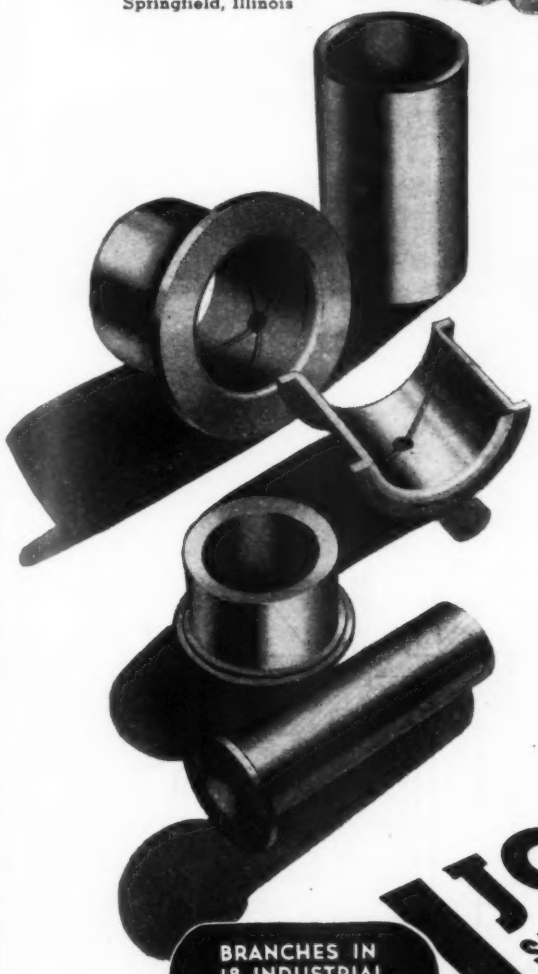
This shows that the elementary method which considers the flywheel as a rotating ring free to expand may not give reliable results for the stress, and that the error is on the unsafe side.

For a theoretical treatment of flywheel stresses, see Timoshenko, "Strength of Materials," page 98, Vol. II, 2nd Edition, 1941.



TOUGH

Baker Hydraulic
Bulldozer made by
Baker Manufacturing Co.
Springfield, Illinois



When an air strip is needed in a hurry . . . or a pillbox is to be demolished . . . the call is for a Bulldozer. In the present war these sturdy earth movers have earned their chevrons along with tanks, guns, planes and ships. Most fighting units class them as indispensable.

The Baker Bulldozer is a good example. In war and in peace they deserve their well earned reputation for being TOUGH. They do their work fast . . . efficiently . . . and keep right on doing it day in and day out. One reason why Baker Bulldozers deliver such excellent performance is that they are equipped with Johnson Sleeve Type Bearings.

Helping manufacturers of all types of equipment to build superior performance into their product is a welcome assignment for Johnson Bronze. When you need advice on any type of bearing application, consult with *Sleeve Bearing Headquarters.*

JOHNSON BRONZE CO.

508 S. MILL STREET NEW CASTLE, PA.

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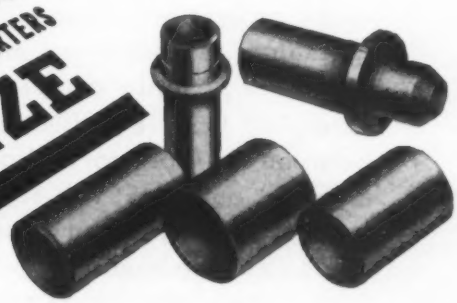

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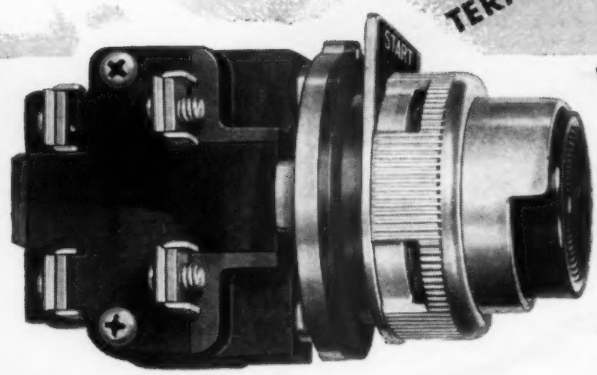
A NEW LINE OF FOR

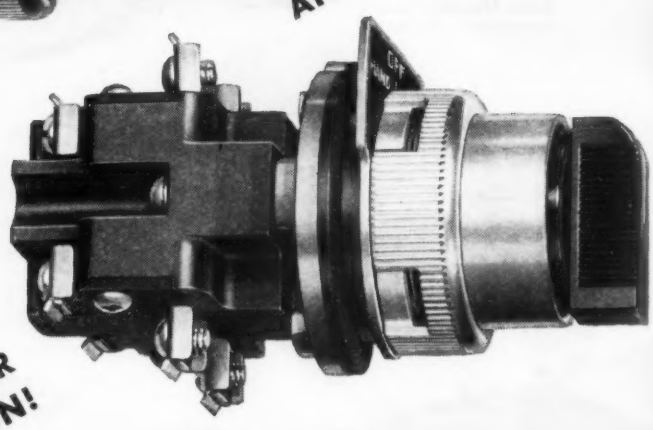
ACCESSIBLE TERMINALS!

MORE COMPACT!

BUILT TO TAKE IT!

MOUNTING IN ANY POSITION!

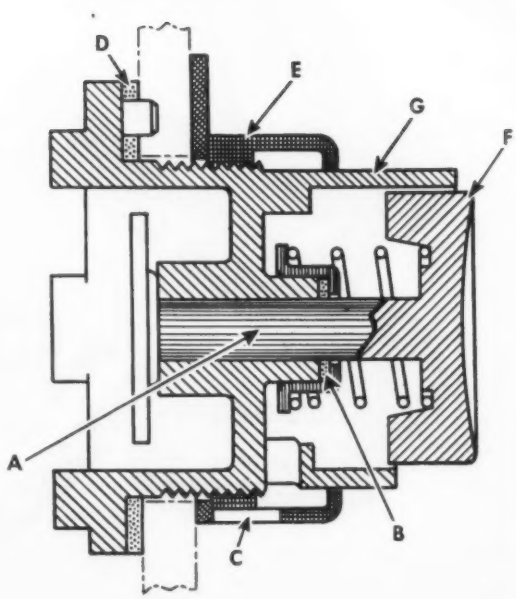




SEPARATE BLOCKS AND OPERATORS!

INTERCHANGEABLE!

MINIMUM STOCK FOR ANY COMBINATION!



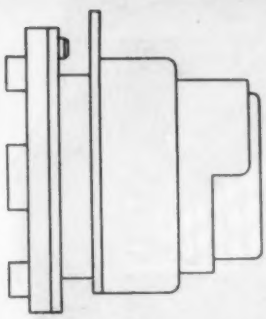
• Separate Operator makes possible an oil-*tight* construction without the use of a diaphragm. The long bearing (**A**), a spring-loaded seal (**B**), and drainage openings (**C**) prevent any leakage of oil, coolant or cutting compound through the Operator, regardless of mounting position. A gasket (**D**), evenly compressed by a threaded clamping ring (**E**), effectively seals the joint between the Operator and panel. The fade-proof, all-metal button (**F**) will stand rough usage and positive stops prevent damage to the Contact Block. The long bearing assures smooth operation over a long life. The relation of the button (**F**) and guard (**G**) is not affected by the thickness of panel in which the Operator is mounted.

OIL-TIGHT PUSHBUTTONS MACHINE TOOL SERVICE

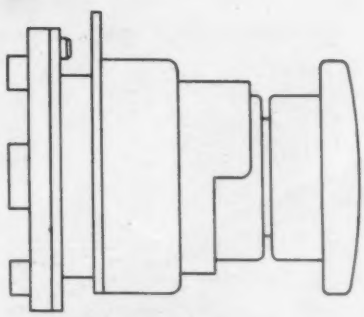
MAXIMUM FLEXIBILITY WITH MINIMUM STOCK

Since any Contact Block may be used with any Operator, combinations to cover a wide range of circuit requirements may be assembled from a limited stock of standard units.

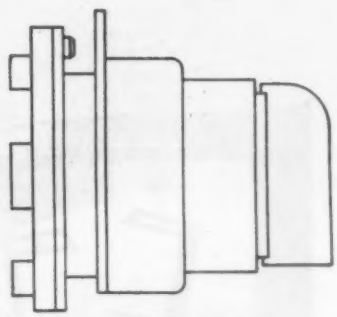
OPERATORS . . .



MOMENTARY CONTACT
GUARDED BUTTON
RED • BLACK



MOMENTARY CONTACT
MUSHROOM BUTTON
RED • BLACK



SELECTOR SWITCH
2 POSITION
3 POSITION

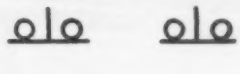
CONTACT BLOCKS . . .

SINGLE POLE
DOUBLE THROW

DUPLEX
DOUBLE THROW

DUPLEX
NORMALLY OPEN

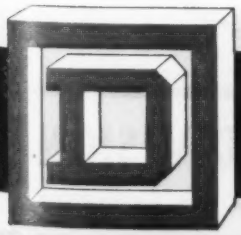
DUPLEX
NORMALLY CLOSED



Although these new Type T units are interchangeable with Types LO and MO units, they can be mounted on closer centers, thus effecting a saving of space for a group of units. Contact Blocks are made of special "non-tracking" material. Contacts are silver, rated for heavy-duty service. Springs are stainless steel. Duplex Contact Blocks function as double-pole units when used with Momentary Contact Operators, but with Selector Switch Operators they function either as a double-pole unit or as two independent single-pole units, depending upon the cam used in the Operator.

★ ★ ★

● See your nearby Square D Field Engineer for further details or write for Bulletin No. 202. Industrial Controller Division, 4041 North Richards Street, Milwaukee 12, Wis.



SQUARE D COMPANY

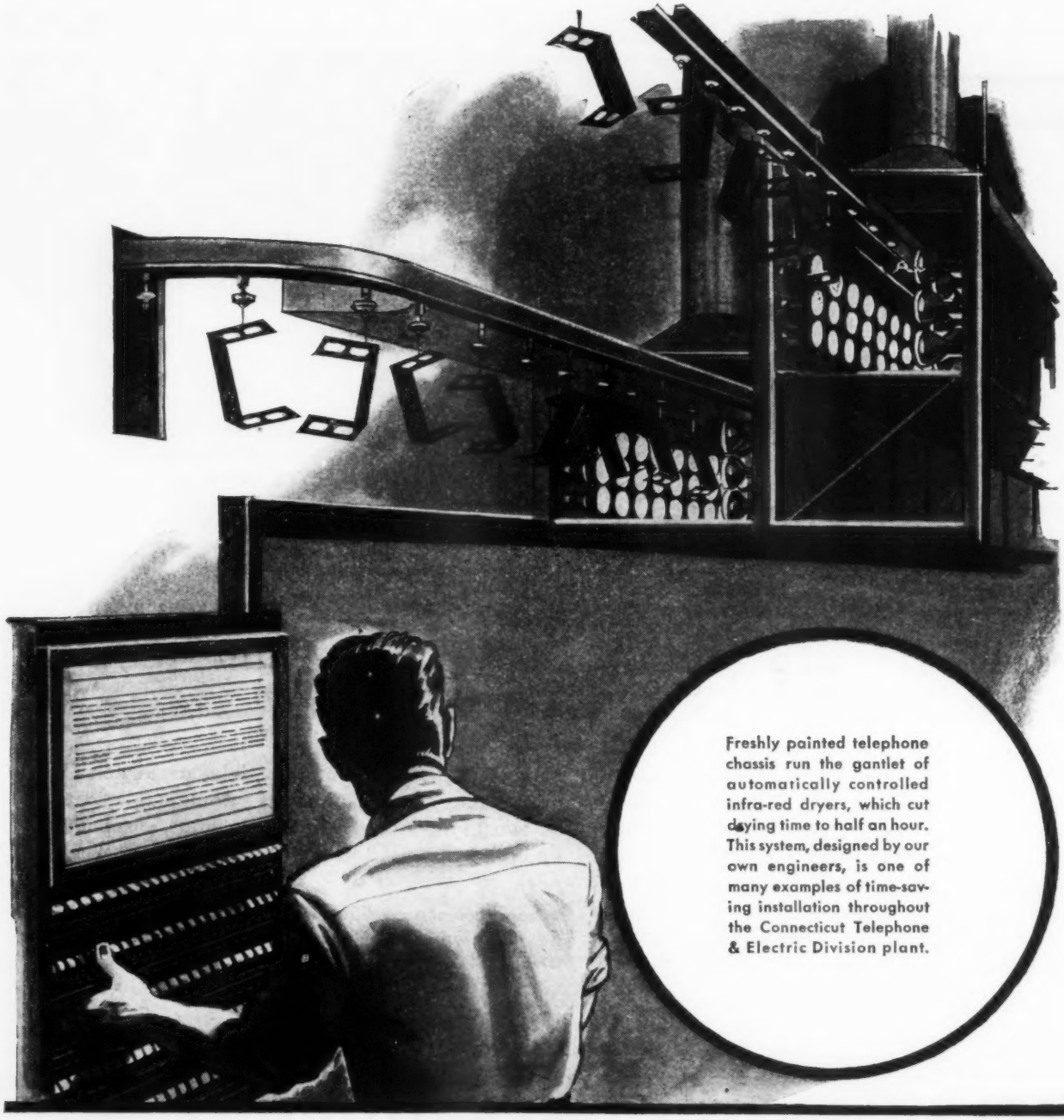
DETROIT • MILWAUKEE • LOS ANGELES

"DO NOT SQUANDER TIME"

. . . Benjamin Franklin

At Connecticut Telephone and Electric Division, production is unhurried, as it must be to maintain accuracy and quality in precision electrical and electronic manufacturing. We substitute *time-saving* methods for *hustle and bustle*. This has enabled us to keep abreast of the ever-increasing need for military communicating equipment of uniform dependability.

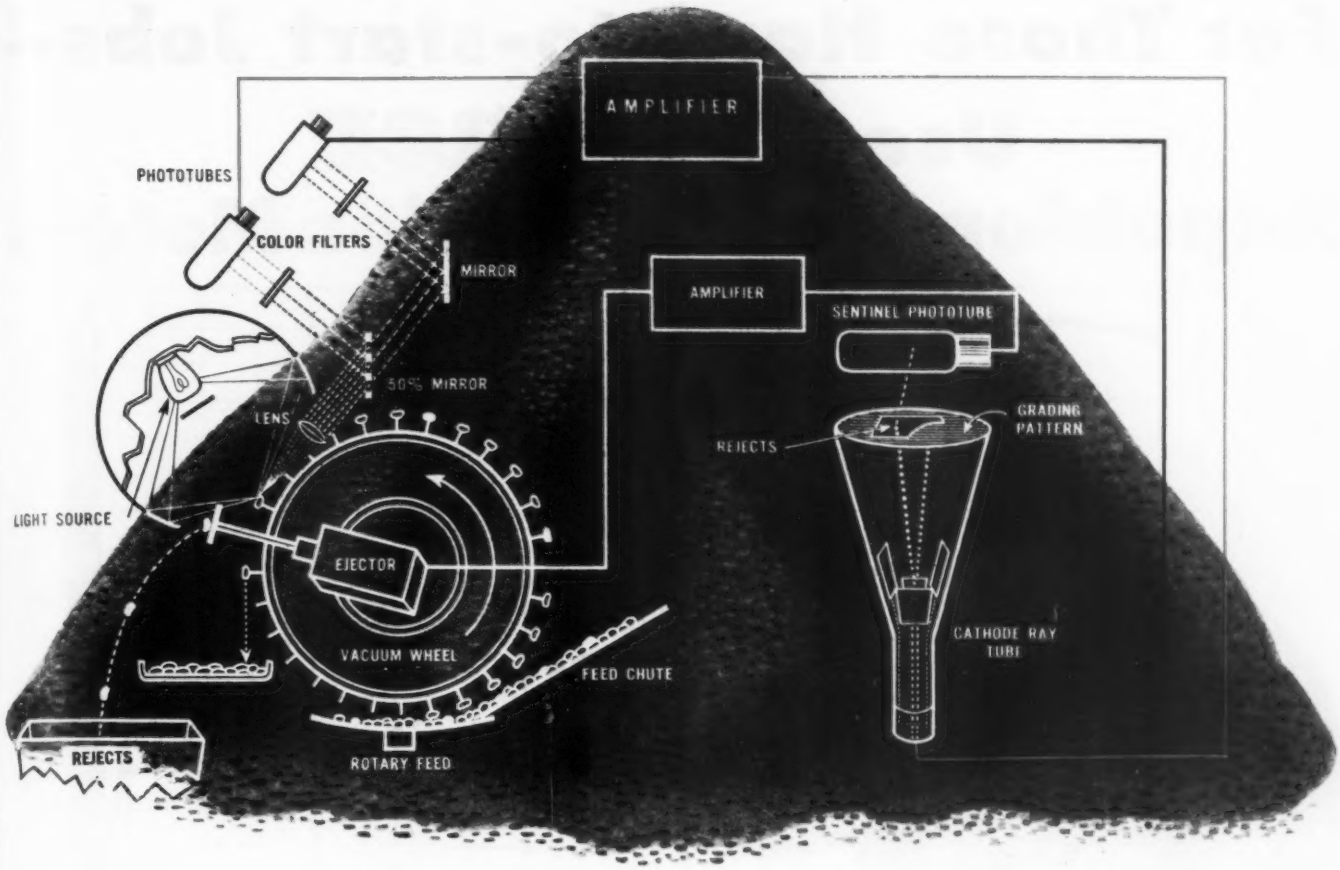
After the war, you will very likely use electrical equipment, electronic devices, or communicating systems made at Connecticut Telephone and Electric Division . . . Or you may be one of the many manufacturers who will use our engineering and manufacturing facilities in connection with your own products . . . In either case, our time-saving methods will be your gain, measured by the important standards of uniform high precision, and speed of filling your orders.



Freshly painted telephone chassis run the gantlet of automatically controlled infra-red dryers, which cut drying time to half an hour. This system, designed by our own engineers, is one of many examples of time-saving installation throughout the Connecticut Telephone & Electric Division plant.

CONNECTICUT TELEPHONE & ELECTRIC DIVISION

GREAT AMERICAN INDUSTRIES, INC. • MERIDEN, CONNECTICUT



How to sort a mountain of beans with RCA Electron Tubes

New Electronic device by Electric Sorting-Machine Co. color-sorts beans, corn, peanuts, coffee, and similar products — faster, better, more economically

AN electronic sorting-machine, developed by Electric Sorting-Machine Company, provides a fast, accurate method of color-sorting. In use throughout the country, this device is saving manpower and money and is speeding vital food-processing. Its ingenious principle is readily adaptable to a multitude of sorting problems.

How It Works: As each bean goes through the machine, it is illuminated by an incandescent lamp. Light reflected from the bean is picked up by two RCA phototubes, one sensitive to red light, the other, to green. The percentage of red and green light reflected from the bean determines its acceptance or rejection.

The output of each phototube is fed into dual-channel amplifiers and from there to opposite deflection electrodes of an RCA cathode-ray tube. The cathode-ray beam is deflected vertically and horizontally in proportion to percentage of red and green light picked up by phototubes.

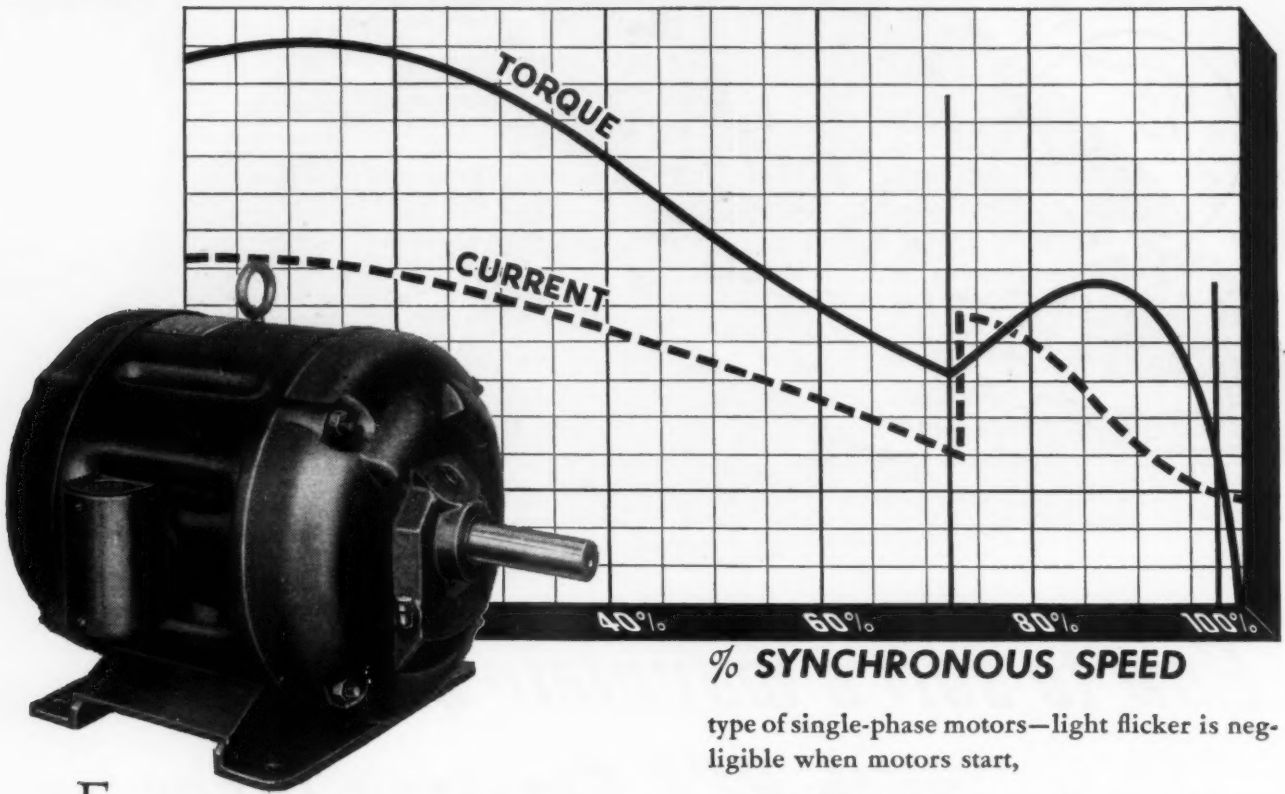
A mask covers one area of the cathode-ray tube screen. The beam falls in this area when the percentage of red and green is acceptable. When the beam falls on the unmasked area of the screen, it means that the color is *not* acceptable. A "sentinel" phototube picks up the "off-color" signal and actuates a relay which rejects the faulty bean.

Turn to Electronics for Solution of Your Own Problems: For information on this equipment, write to Electric Sorting-Machine Company, Grand Rapids, Michigan.

Electron tubes are providing a practical solution to hundreds of diversified manufacturing problems—process-control, machine-control, heat-treating, plant-protection, and a host of others. Consult with RCA tube-application engineers for information or advice on use of electron tubes in the design of your own equipment. For examples of electronics at work in our own factories, send for the free booklet "Electrons in Action at RCA." Write to RCA, Commercial Engineering Section, Dept. 62-54Y, Harrison, New Jersey.

THE FOUNTAIN-HEAD OF MODERN TUBE DEVELOPMENT IS RCA

For Those Hard-to-start Jobs—
Use Wagner
Repulsion-Start Induction Motors



For almost 50 years, we have been building repulsion-start induction motors, and today the majority of fractional-horsepower motors we make are still of the same type.

Notwithstanding the development of other types of single-phase motors during all those years, the repulsion-start induction type is still the preferred motor for compressors, pumps, stokers, and other machinery involving heavy starting-loads—because repulsion-start induction motors

1. start high-inertia loads and accelerate them smoothly,

2. have lower starting-current than any other type of single-phase motors—light flicker is negligible when motors start,

3. have high operating speeds even under considerable overloads, and

4. have a flat efficiency curve over a wide operating range.

For complete description of Wagner repulsion-start induction motors, ask for Bulletin MU-183 or write the nearest of our 29 branch offices, at Atlanta 3, Baltimore 18, Boston 15, Buffalo 8, Chicago 16, Cincinnati 10, Cleveland 15, Dallas 1, Denver 2, Detroit 2, Houston 2, Indianapolis 4, Kansas City 8, Los Angeles 15, Memphis 3, Milwaukee 2, Minneapolis 4, New York 7, Omaha 2, Philadelphia 8, Pittsburgh 13, Portland 9, St. Louis 3, Salt Lake City 1, San Francisco 3, Seattle 4, Syracuse 2, Tulsa 3, and Washington 5.

MOTORS
are but one of several
WAGNER PRODUCTS
serving industry.

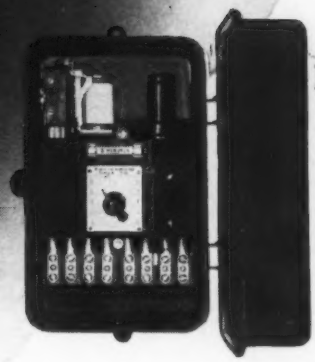
Other WAGNER PRODUCTS:
AIR BRAKES
BRAKE LINING
HYDRAULIC BRAKES
INDUSTRIAL BRAKES
INDUSTRIAL BRAKE CONTROLS
TACHOGRAPH (Recording Speedometer)
TRANSFORMERS

M45-3

Wagner Electric Corporation
ESTABLISHED 1891
6406 Plymouth Avenue, St. Louis 14, Mo., U. S. A.
ELECTRICAL AND AUTOMOTIVE PRODUCTS

THROUGH THE MIRACLE OF ELECTRONICS

PHOTOSWITCH provides modern industry with more than 50 types of electronic CONTROLS for . . .

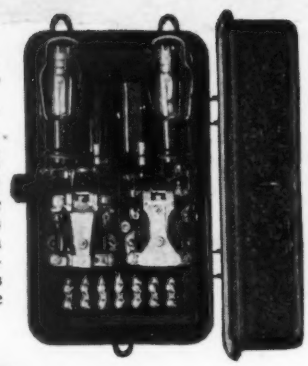


TIMING

Photoswitch Timers are universal for time delay and interval timing from .05 sec. to two minutes. Extensively used on Injection Moulding Machines, X-Ray Apparatus, Automatic Spraying Equipment, Process Control, Automatic Machine Tools, Welding Equipment, Embossing Presses, Automatic Ship Whistle Control, etc. Electronic operation eliminates moving parts, friction, wear — guarantees unlimited-life accuracy. Reference Bulletin 901A.

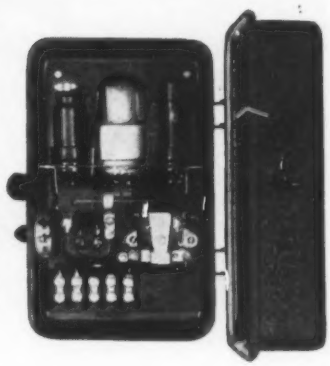
LIQUID LEVEL

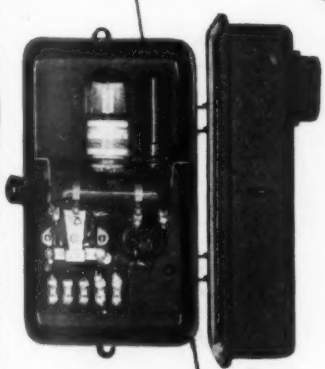
Photoswitch Level Controls are standard equipment on pumps, tanks, stills, refrigerating systems, etc. — control level of any liquid (or powder) electronically. Control is floatless — only metal probe contacts material. Liquid itself, as it makes or breaks contact with probe tip, actuates electronic control relay — automatically operates signals, valves, pumps. Reference Bulletin 1100.



TURBIDITY

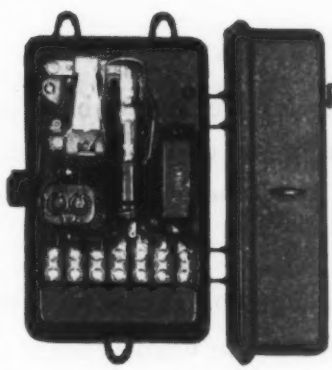
Photoswitch Controls are adaptable to practically all turbidity problems (even when transparency is very low) — actually "see" through liquids, reporting minute turbidity changes invisible to human eye. Densometer in control circuit gives continuous meter indication of turbidity change. Sensitivity adjustment on control may be set so that relay will flash signal, sound alarm, operate valves or pumps — at any predetermined degree of turbidity. Reference Bulletin 315.





ELECTRIC EYE

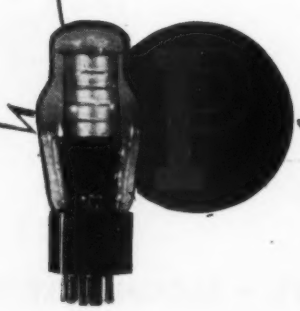
Photoswitch Type A15 is one of a wide variety of photoelectric controls available for hundreds of machinery applications. Beam of light is projected across conveyor, bed of machine, or any area to be controlled, to the photoelectric control. Objects breaking beam actuate relay — operating electrical counter, machinery safeguard, stop motion mechanism, etc. Reference Bulletins 310 and 312.



PILOT RELAY

Photoswitch Pilot Relays make possible the control of large currents by delicate mechanisms, or extremely light contact pressure. Used on textile looms, warpers and winders — also on paper processing equipment for stop motion control on break detection. Monitors feed, keeps production count, on automatic punch presses — also used as limit switch on machine tools. Reference Bulletin 900A.

Write for Special Bulletins describing any or all of the Photoswitch Controls illustrated.



PHOTOSWITCH Photoelectric and Electronic Controls provide completely automatic machine operation, release needed manpower, speed war production — can be incorporated in the design of any electrically operated machine, or can be quickly and easily installed on machinery already in operation. The engineering staff of Photoswitch Incorporated will welcome the opportunity to assist in the solution of your automatic control problems. Write today for further details on standard PHOTOSWITCH equipment, or for recommendations on how PHOTOSWITCH controls can be adapted to meet your specific requirements.

PHOTOSWITCH INCORPORATED

PHOTOELECTRIC & ELECTRONIC CONTROLS FOR EVERY INDUSTRIAL PURPOSE

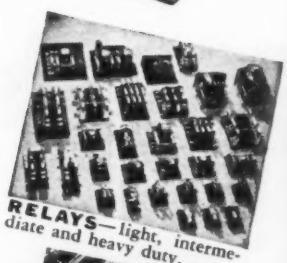
CAMBRIDGE, MASS. • *District Offices* IN ALL PRINCIPAL CITIES

CONTROLS FOR WORLD MARKETS

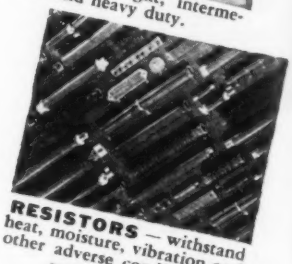
Ward Leonard Controls have an enviable record of performance in war equipment. On the sea, under the sea, on the ground, and in the air — subjected to widely varying climatic conditions in all parts of the world!

Obviously manufacturers who are planning world-wide postwar markets can be certain that the Ward Leonard controls they incorporate in their products will give continuous trouble-free service.

Write for our catalogs describing the types of controls you need.



RELAYS—light, intermediate and heavy duty.



RESISTORS — withstand heat, moisture, vibration and other adverse conditions.

RHEOSTATS—wide range of sizes, types and current ratings from ring types to industrial assemblies.

WARD LEONARD

RELAYS • RESISTORS • RHEOSTATS

ARMY E NAVY

Electric control (WL) *devices since 1892.*

WARD LEONARD ELECTRIC COMPANY · 63 SOUTH ST. · MOUNT VERNON, N Y.

START AND ACCELERATE Smoothly with RELIANCE V•S DRIVE!

(Photo courtesy Western Electric Company)

Each of these wire-twisting machines is driven and controlled by its individual Reliance V•S Drive—for *smooth* starting and *smooth* acceleration.

V•S is an all-electric, adjustable-speed drive, operating from AC circuits, through which starting, stopping and speed changes are effectively controlled, automatic reversal provided at any desired point and tension properly maintained. The possibilities of Reliance V•S Drive in helping to speed production and cut costs are almost limitless. It will pay you to investigate.

Four rubber-covered conductors and the plastic center filler are twisted into "Spiral-4" cable for use on the fighting fronts by this battery of machines, at the Point Breeze Works of the Western Electric Company.

Here, as in many other applications, Reliance V•S Drive has provided the smoothness and flexibility of control which are vital to speed and quality of production. Low creeping speeds for adjustment virtually eliminate wastage, starting and acceleration are free from jerks or irregular motion and both quantity and quality of production are maintained at a high level.

For complete information as to the possibilities of Reliance V•S Drive, call the nearest Reliance office, or write for Bulletin 311.

RELIANCE ELECTRIC & ENGINEERING CO.

1080 Ivanhoe Road • Cleveland, Ohio

Birmingham • Boston • Buffalo • Chicago • Cincinnati • Detroit • Greenville (S. C.) • Houston
Kalamazoo • Los Angeles • Minneapolis • New York • Philadelphia • Pittsburgh • Portland (Ore.)
St. Louis • San Francisco • Syracuse • Washington, D. C. • and other principal cities

RELIANCE A-C D-C MOTORS

"Motor-Drive is More Than Power"

SENSITIVITY

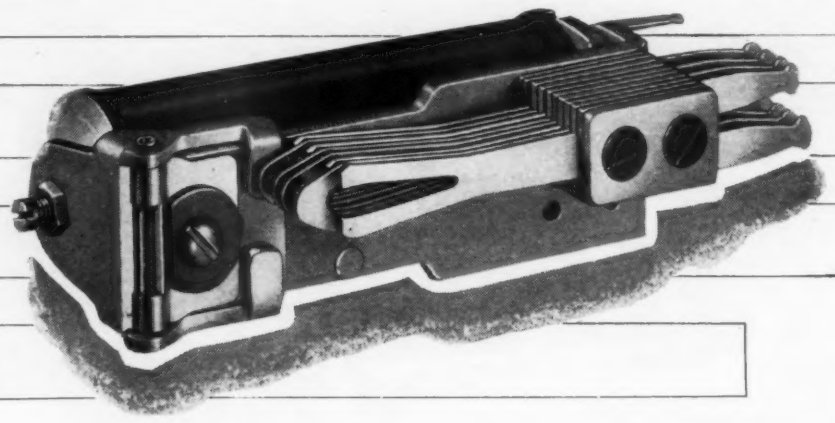
CONTACT PRESSURE

DEPENDABILITY

DURABILITY

COMPACTNESS

VERSATILITY



— *in Greatest Combination*

THE NEW AUTOMATIC ELECTRIC CLASS "B" RELAY

• When you need a relay that's sensitive enough to operate on minute current, yet has the high contact pressure needed for perfect closure, you'll find the Automatic Electric Class "B" Relay worth investigating.

If you need a relay that will switch many circuits, yet is compact enough for multiple mounting in small space, you'll find Class "B" the perfect solution.

Or perhaps you are interested in extra durability, for long service under tough conditions. Then you'll need the in-built quality for which Class "B" has become famous.

No other relay—even in the Automatic Electric line—can give you a greater combination of all these essential qualities. Get the full story on Class "B"—one of the forty basic types described in the Automatic Electric catalog. Ask for your copy of Catalog 4071.

CHECK THESE FEATURES of the New Class "B" Relay

Independent Twin Contacts—for dependable contact closure.

Efficient Magnetic Circuit—for sensitivity and high contact pressure.

Unique Armature Bearing—for long wear under severe service conditions.

Compact Design—for important savings in space and weight.

Versatility—Available for coil voltages to 300 volts d-c and 230 volts a-c, and with capacities up to 28 springs; also with magnetic shielding cover, when specified.

No other relay can give you a greater combination of all these essential qualities.

Relays
AND OTHER CONTROL DEVICES
by AUTOMATIC ELECTRIC

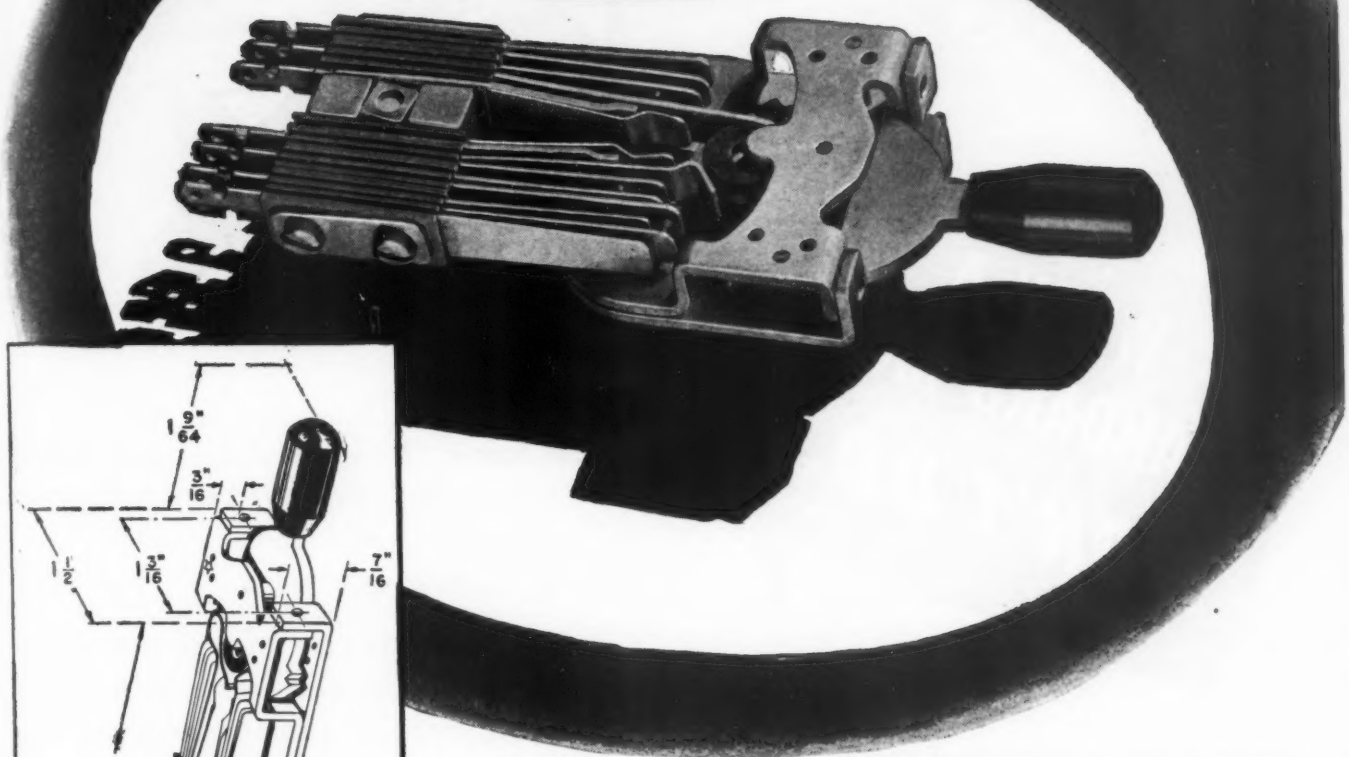
AUTOMATIC ELECTRIC SALES CORPORATION
1033 West Van Buren Street • Chicago 7, Illinois

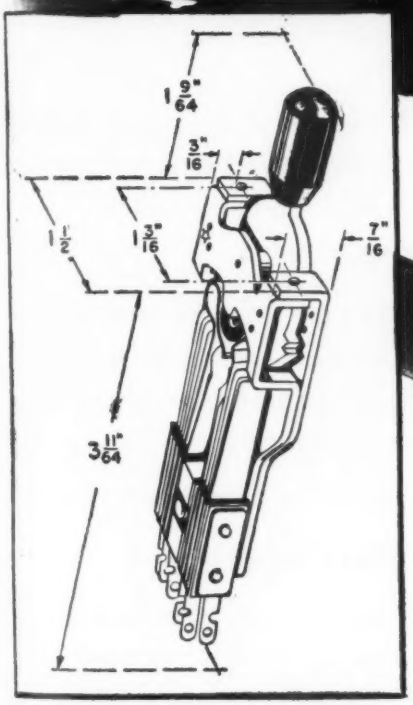
In Canada: Automatic Electric (Canada) Limited, Toronto

PARTS AND ASSEMBLIES FOR EVERY ELECTRICAL CONTROL NEED

The Little GIANT

FEDERAL'S *New* LEVER KEY





- Small Size—5/8" horizontal mounting centers.
- Large Spring Capacity — 18 springs; over 500 possible combinations.
- Palladium Contacts . . . Nickel Silver Springs.
- High-Quality Phenolfibre Insulation.
- Universal Cam — 1 or 2 way — locking or non-locking.
- Free-Moving Roller . . . Positive Snappy Action.

Designed for finger-tip control of electronic and communications equipment where size is important, the FTR-810 Series Lever Key occupies less than half the horizontal mounting space required for older types.

And at the same time, its eighteen nickel-silver springs and low-resistance palladium cross-bar contacts permit more than five hundred possible switching combinations.

High-quality phenolfibre insulated throughout, the overall simplification in design has resulted in a more rugged, dependable lever key with a positive, snappy action that once set — stays set.

The universal cam has an unusually long bearing surface for smooth action and long life . . . for either locking or non-locking operation . . . one or two-way, simply by a change in position of the stop pins.

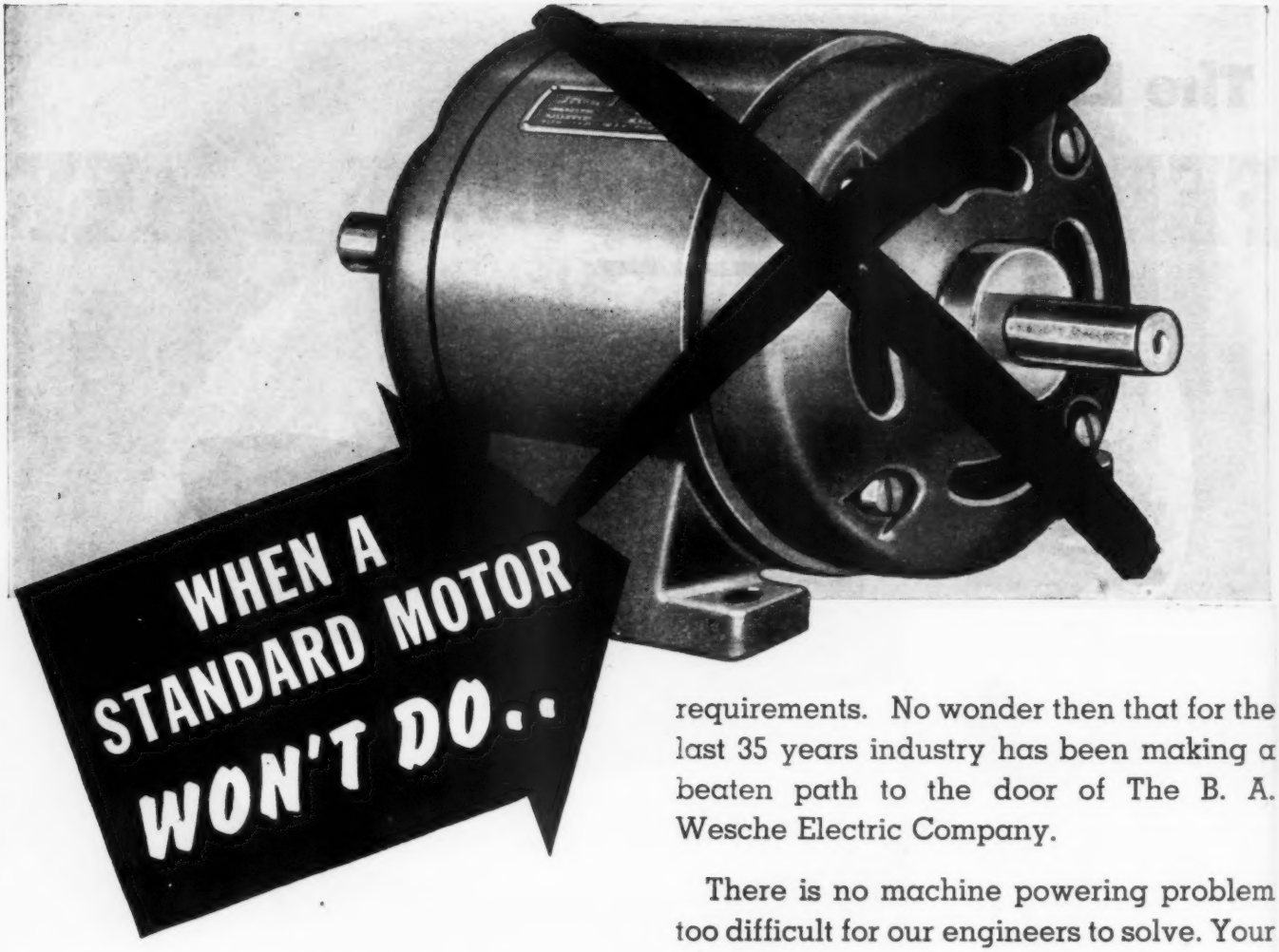
Here is another compact component by Federal with a wide variety of applications in control circuits, and another reason to see Federal first for electronic and communications equipment.

FEDERAL TELEPHONE AND RADIO CORP. FTR

Federal Telephone and Radio Corporation

I&T ASSOCIATE

...ark 1, New Jersey



—consult the specialist of special torque motors, The B. A. Wesche Electric Company.

Manufacturers of machine tools and machines of every description have come to Wesche with their special powering and application problems. Not one went back empty-handed. Their problems were solved by a Welco Torque Motor, custom-built to meet all the special or specific powering requirements. No wonder then that for the last 35 years industry has been making a beaten path to the door of The B. A. Wesche Electric Company.

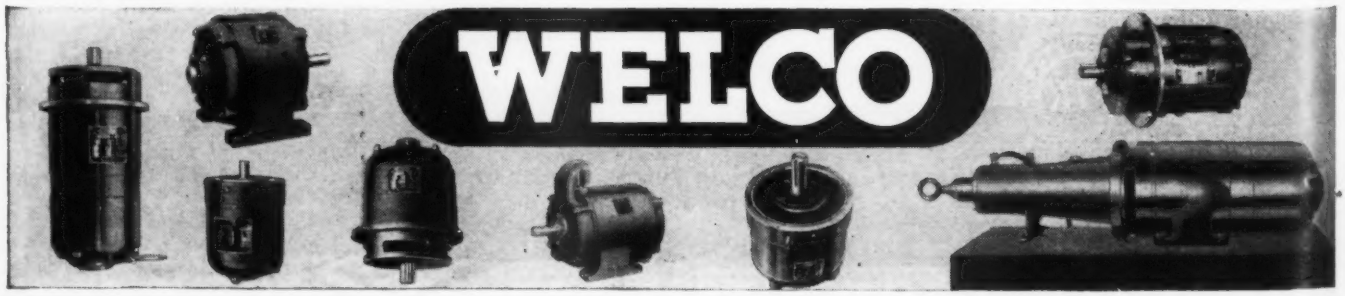
There is no machine powering problem too difficult for our engineers to solve. Your inquiry will receive prompt and cooperative attention. Write today.

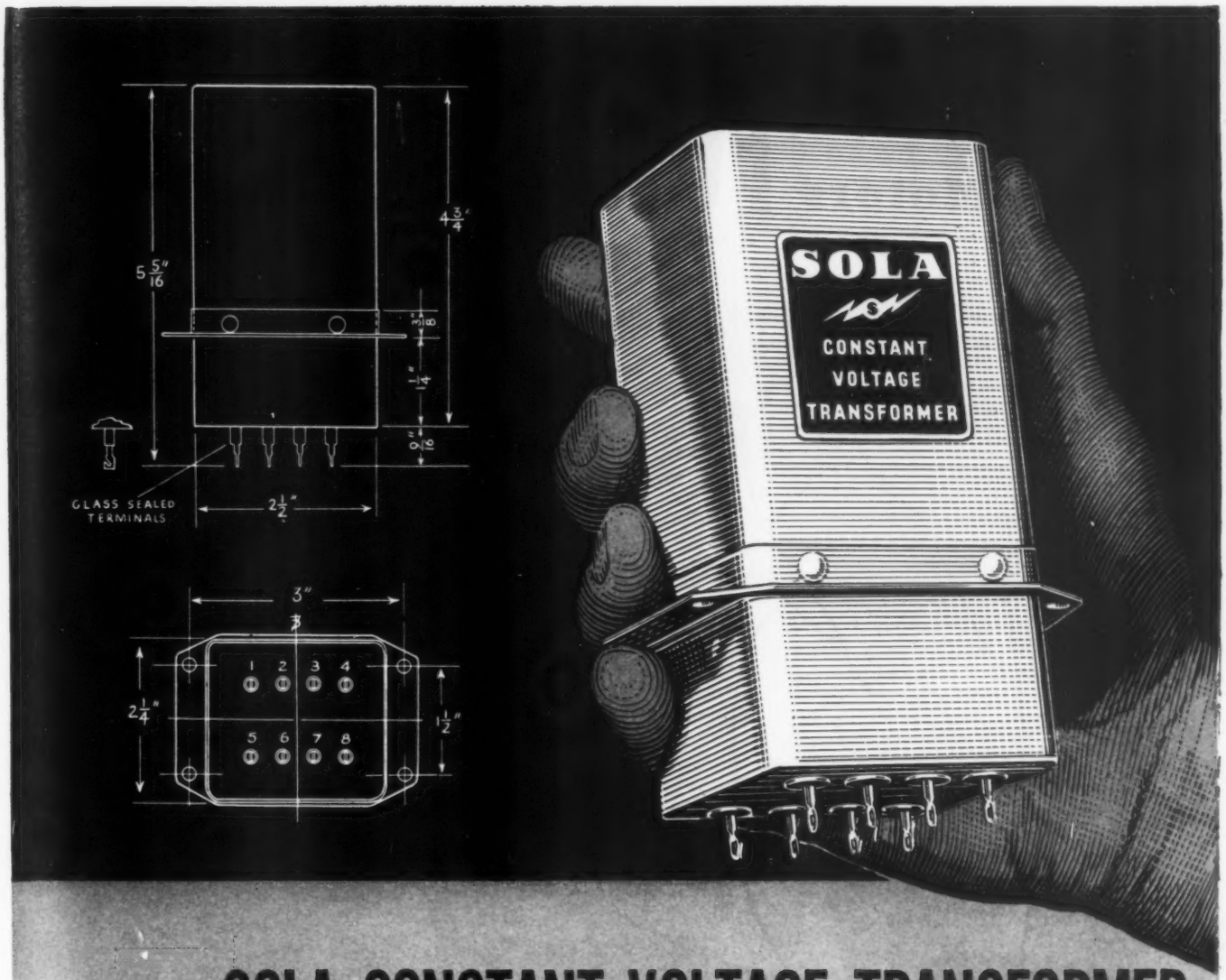
EXCLUSIVE FEATURE

The "Uniframe" construction of the Welco Torque Motor provides for an easy interchange of A.C. and D.C. motors to fit the same housing or frame. Only WELCO has this vitally important feature.

The B. A. WESCHE ELECTRIC Co.

1620-2 Vine St. Cincinnati 10, Ohio





Another SOLA CONSTANT VOLTAGE TRANSFORMER

that has an important future in *YOUR* postwar plans

There may be one vulnerable spot in the design of *your* equipment that this SOLA Constant Voltage Transformer will correct.

Your customers do not have the stable line voltage called for on your label. They will blame *your* equipment for inefficient operation, *not* the fluctuating voltages that really cause it.

Build this SOLA Constant Voltage Transformer into your product and you can be certain that the operating voltages will always be within ±1% of rated requirements regardless of line fluctuations as great as 30%.

This SOLA Constant Voltage Transformer is built to fit your equipment. (Note the small, compact dimensions.) Its low cost will fit your production budget. Its automatic operation will eliminate the need for other costly components, and relieve your customers of the responsibility of making manual voltage adjustments.

There's a powerful sales story behind a product equipped with a SOLA Constant Voltage Transformer.

SOLA Constant Voltage Transformers

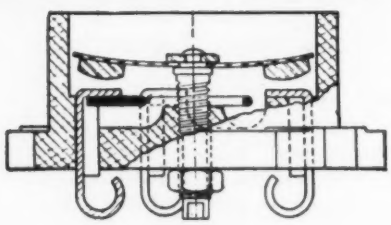
To Manufacturers:
Built-in voltage control guarantees the voltage called for on your label. Consult our engineers on details of design specifications.

Ask for Bulletin 14CV-103

Transformers for: Constant Voltage • Cold Cathode Lighting • Mercury Lamps • Series Lighting • Fluorescent Lighting • X-Ray Equipment • Luminous Tube Signs Oil Burner Ignition • Radio • Power • Controls • Signal Systems • Door Bells and Chimes • etc. **SOLA ELECTRIC CO., 2525 Clybourn Ave., Chicago 14, Ill.**

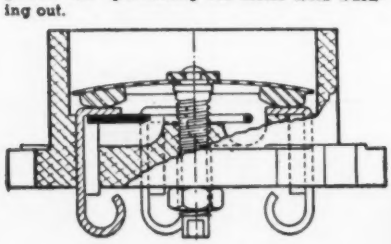
It Gives Motors FULL LIFE Expectancy

Here's how it works



CLICK! IT'S OFF!

Should a motor become overheated and dangerously hot, the Klixon Protector snaps the power "off" preventing the motor from burning out.



CLICK! IT'S ON!

When the motor cools to safety, the Klixon Protector snaps the power "on" automatically if the automatic reset is specified . . . or when the reset button is pushed when manual type is specified.

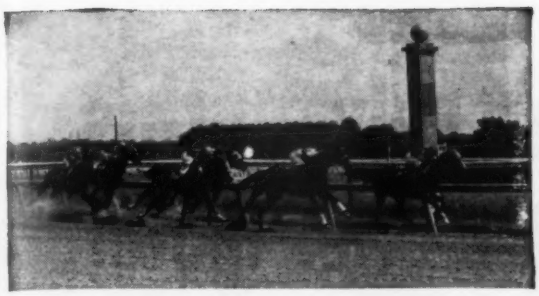
You can get complete protection against motors overheating and burning out by specifying motors with Klixon Built-in Motor Protectors. These protectors take into account all the causes of motors overheating and cut the motor "off" the line whenever motor temperature reaches the danger point regardless of the cause.

Because Klixon Protectors are built into motors by the motor manufacturer, you get a tested and proven combination of protectors properly matched to the motors allowing maximum safe operating capacity without under- or over-protection of the motors. The illustrations at left show and describe the operation of Klixon Protectors.

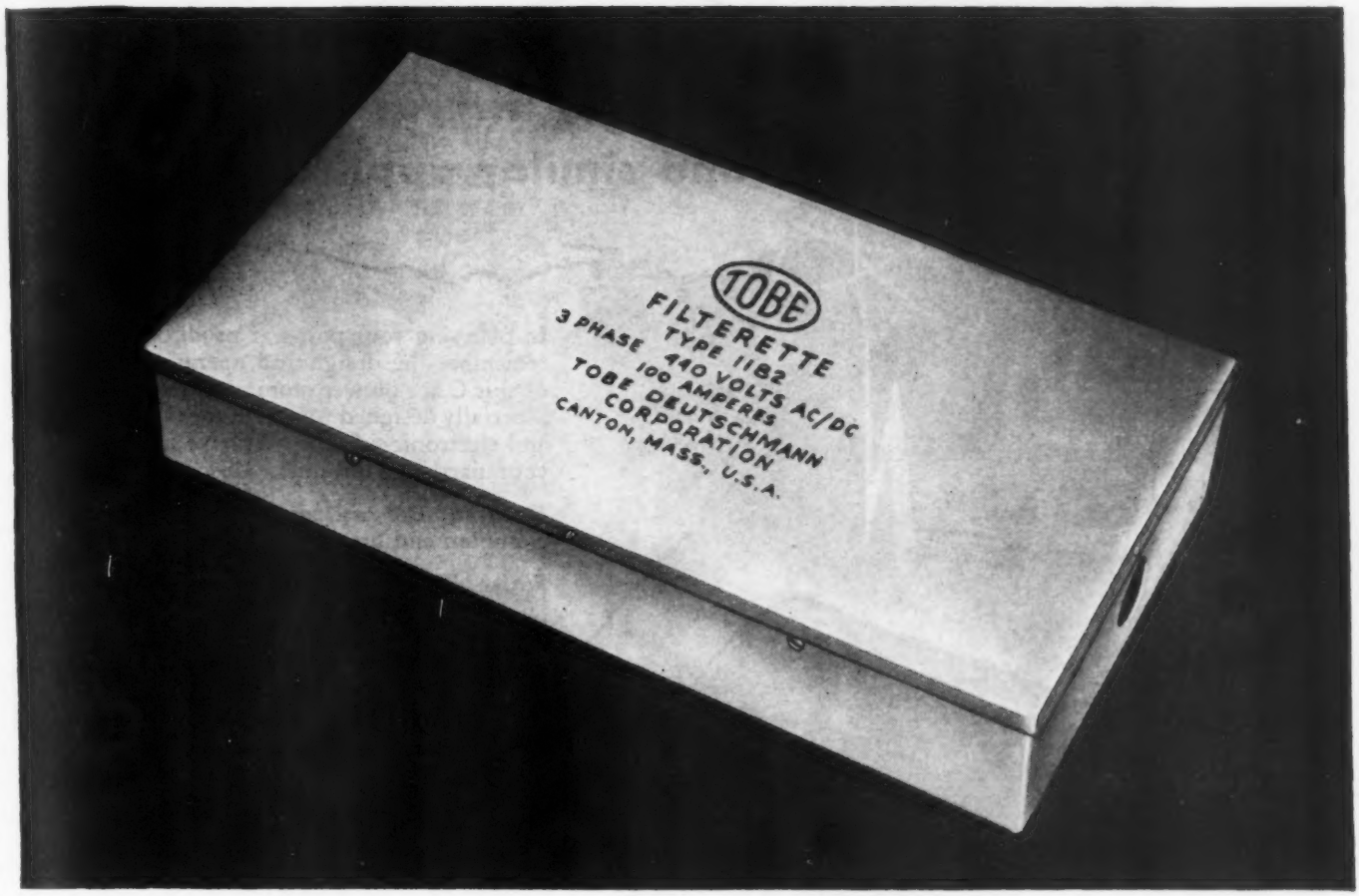
Get full motor life from your motors by buying motors with Klixon Built-in Motor Protectors. They are available with A.C. motors all sizes; D.C. motors up to 30 volts in automatic or manual reset types.

KLIXON MOTOR PROTECTORS

SPENCER THERMOSTAT CO., ATTLEBORO, MASSACHUSETTS



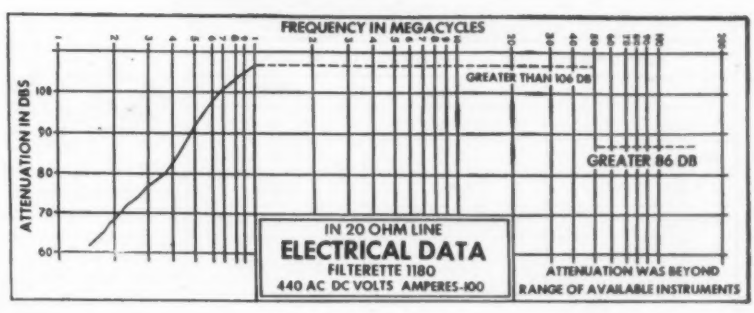
AWAY AHEAD!



Tobe Leads the Noise Elimination Field

FEW problems are as vexing as the elimination of unwanted radio interference set up by the operation of nearby electric motors. And few sources of engineering advice on this subject are as experienced as the Tobe Engineering Staff. *Tobe is the acknowledged leader in this field;* our organization has devoted 17 years to the intricate problems of noise elimination.

The large #1182 Navy-Type Filter illustrated above is an example of our specialization. Examine the curve and container dimensions. This is only one of a large number of filters designed to meet special needs. Send for complete details. Let us help you solve any problem connected with blotting out unwanted "man-made" radio static. Your inquiries are welcome.



TOBE DEUTSCHMANN CORP., CANTON, MASS.

GRAND CENTRAL TERMINAL BUILDING
NEW YORK 17, N. Y.

110 WEST BROADWAY
GLENDALE 4, CAL.

230 NORTH MICHIGAN AVE.
CHICAGO 1, ILL.

2-159 GENERAL MOTORS BLDG.
DETROIT 2, MICH.

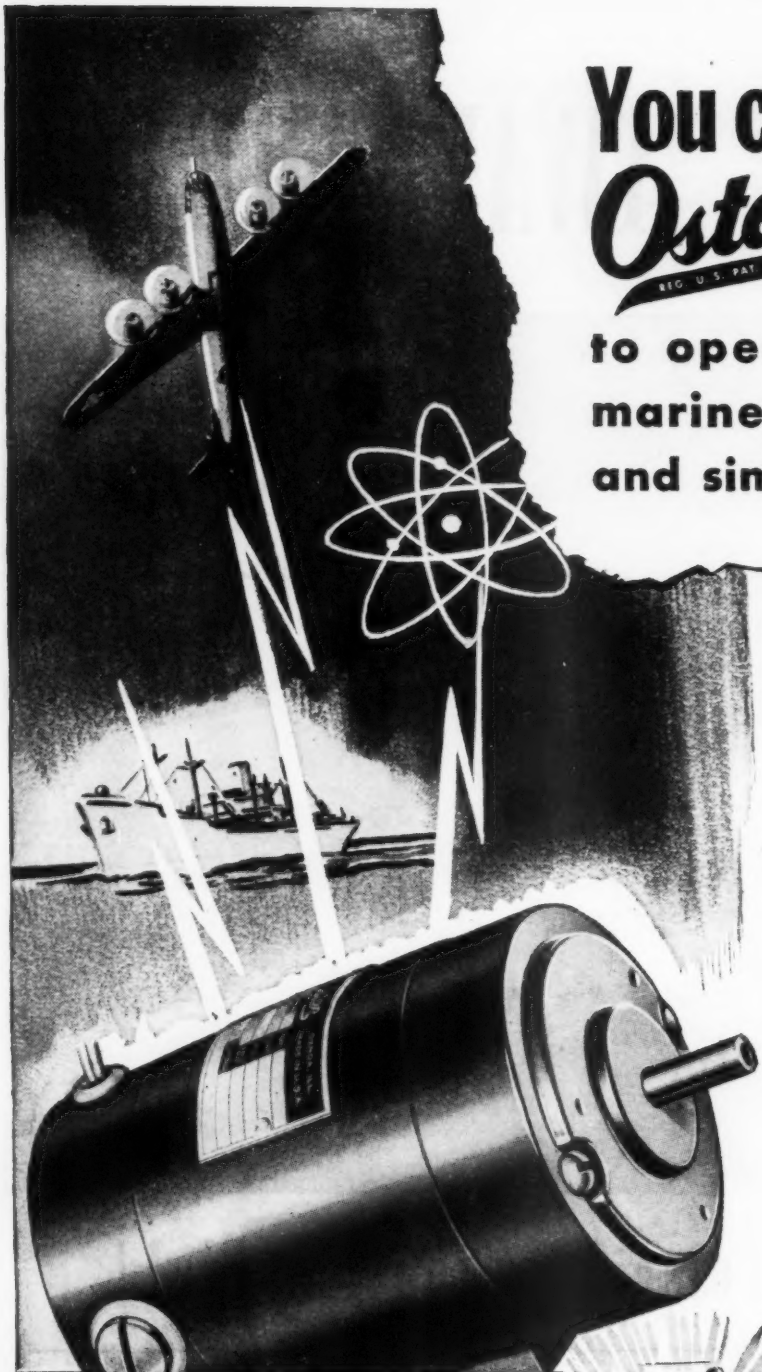
SUPPRESS MAN-MADE RADIO STATIC
TOBE
FILTERIZED

TYPE 1182—ATTENUATION RANGE
150 KC to 150 MC

CONTAINER DIMENSIONS

Length . . 22 1/8" Height . . 4 1/8"
Width . . 11 7/8"

This unit contains three #1180 Filterettes, each bearing Navy-Type No. CTD 53177.



You can rely on this Oster Blower Motor

REG. U. S. PAT. OFF.

to operate dependably in marine, aircraft, electronic, and similar applications . . .

In planning your post-war product, it is well to remember the design and operating advantages of this Oster blower motor. Although it has been especially designed for use in the marine, aircraft, and electronic fields, it may have qualities that fit your particular product. Check these features:

Housing: Die cast, zinc field housing and aluminum end brackets. Totally enclosed.

Finish: Black baked enamel.

Weight: 5 lbs.

Bearings: Single shielded ball bearings lubricated with a grease suitable for any specific application. Bearing housings fitted with steel inserts.

Windings and Insulation: Field coils and armature wound with a select grade of insulated copper wire and impregnated with a high quality heat and moisture resisting insulating varnish.

Mounting: Available with either base mounting or machined pads.

Brushes: Metal graphite or electro-graphite brushes of ample size to assure unusually long brush life. Phosphor bronze or beryllium copper brush springs.

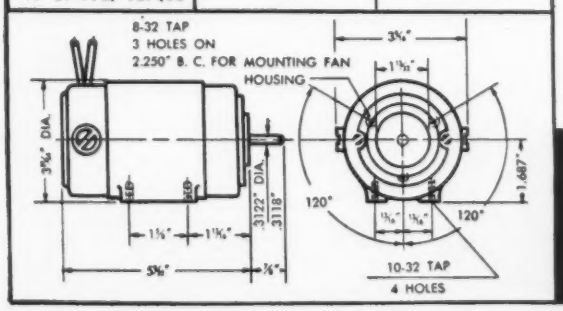
Temperature Rise: 55°C. maximum frame temperature rise at rated output.

Modification: Motors can be furnished with special shaft extensions, mounting arrangements, finishes, leads, etc.

Let us help you fit this and other Oster Motors to your requirements.

Buy **WAR BONDS**

PERFORMANCE WITH #3 L-R TURBO TYPE BLOWER		
Type	F-9A-3	F-9-4S
Voltage	115 A.C. 60 CYC.	27 D.C.
Amps. Input	2.7	7
R.P.M.	6000	6000
Rotation	Clockwise Drive End	Clockwise Drive End
Starting Torque in % of F. L. Torque	200	300 — 400



You can recommend Oster Motors with full assurance that they will live up to the world-wide reputation of pre-war Oster appliances, Oster-powered.

M-24

John Oster Manufacturing Co.

DEPARTMENT P-24 • RACINE, WISCONSIN

IT IS EASY to see that both these gentlemen are satisfied customers of General Industries. One acclaims our "know-how" in molded plastic parts — the other our velvety *Smooth Power* motors. Yes, we do both jobs under one roof and one management.

GENTLEMEN, *YOU'RE BOTH* RIGHT!

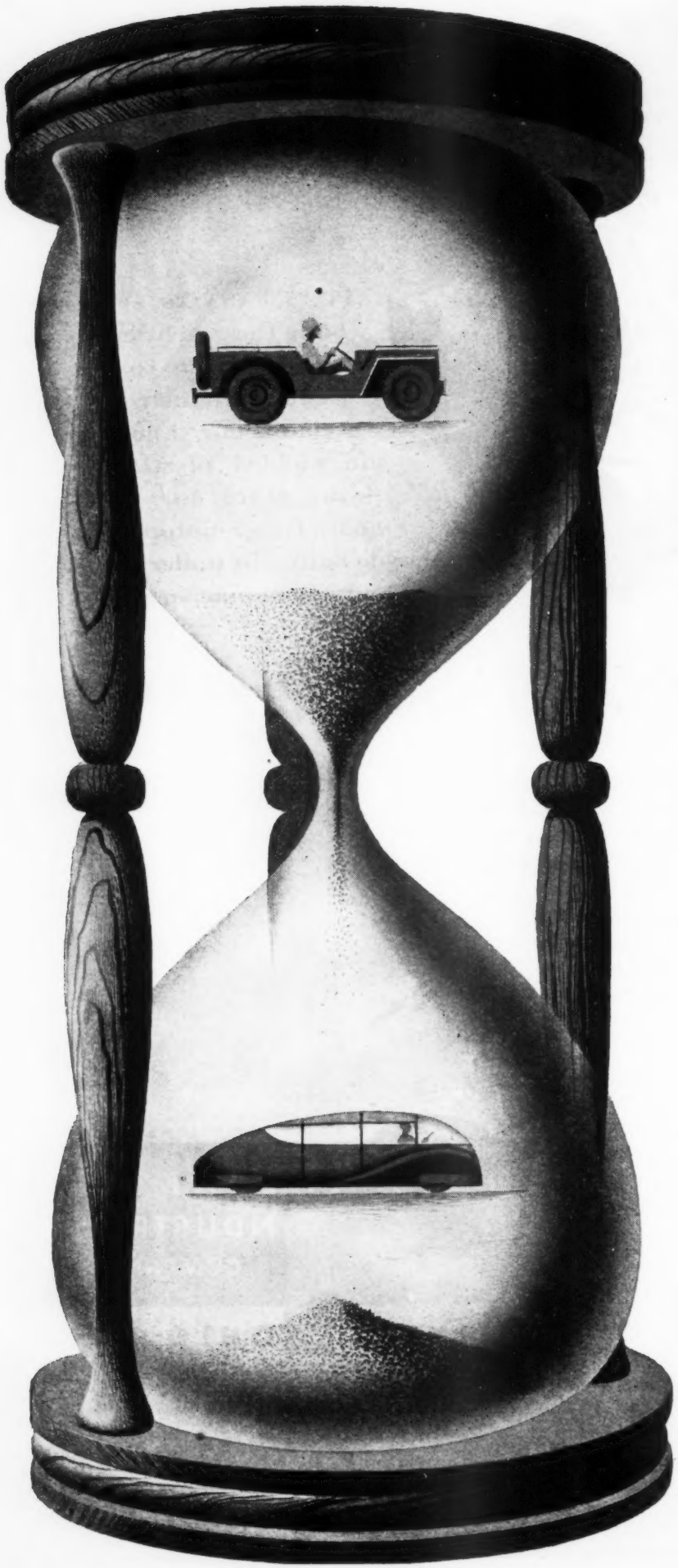
The plastic parts buyer has profited from the ingenious skill of our mold makers, who enable us to turn out tricky jobs economically and on time. Quite likely he has seen our up-to-date equipment for compression, transfer and injection molding of large or small parts in any quantities. Our engineers have made sensible and workable suggestions, by reading between his blueprint lines. He is typical of leading manufacturers in many fields who rely upon General Industries plastics division.

The speaker on *Smooth Power* motors might be a radio-phonograph builder who uses our turntables, record changers and recorders. Or he might be a designer who depends upon these fine low-torque drives to power electric, electronic or mechanical devices. In any case, he's well acquainted with the facilities of our *Smooth Power* motor division.

We want to emphasize the point that we're a thoroughly able producer of both these products. If your plans call for either or both, we'd like to work with you. In your request for details, please address the respective division . . . *small motors* or *plastics*.

THE GENERAL INDUSTRIES COMPANY
ELYRIA, OHIO

ARMY E NAVY



WILCO facilities Expanded to Meet Wartime Needs!

But Postwar Industry will be the ultimate gainer from the many new WILCO products and developments

As the Hourglass indicates . . . at the coming of peace, the skill and experience gained in the development and application of new WILCO products and techniques will mean much to automotive, electrical appliance and many other types of manufacturing customers.

Though now chiefly applied to the war effort, these new WILCO developments are destined to play as vital a role in the postwar industrial "comeback" as they are now playing in scores of wartime applications.

Thermostatic Bimetals, Electrical Contacts, and Precious Metal Bimetallic Products are such important factors in the precision performance of ships, planes, tanks, guns, and various instruments of the Army and Navy that the H. A. Wilson Company has found it necessary to enlarge its facilities and develop these important new products and techniques.

In the postwar period no company will be better equipped to meet individual requirements for Thermostatic Bimetals and Electrical Contacts on any desired scale than the H. A. Wilson Company, pioneers in this field.

WILCO PRODUCTS ARE: *Contacts*—Silver, Platinum, Tungsten, Alloys, Sintered Powder Metal, *Thermostatic Bimetal*—High and Low Temperature with new high temperature deflection rates. *Precious Metal Collector Rings* for rotating controls. *Silver Clad Steel*—for bearings, shims, reflectors, *Jacketed Wire*—Silver on Steel, Copper, Invar, or other combinations requested. *Silver Clad Steel. Rolled Gold Plate.* Special Materials.

THE H. A. WILSON COMPANY

105 Chestnut Street. Newark 5, New Jersey

WILCO

Thermometals—Electrical Contacts
Precious Metal Bimetallic Products

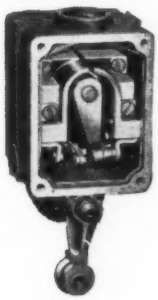
2000 PERFORMANCE RECORDS in 2000 different uses

SNAP-LOCK TRADE MARK LIMIT SWITCHES

have done so many jobs so well that they are now used by more than 80% of all the builders of machine tools.

Snap-Lock superior design and construction puts an end to the common causes of limit switch failure.

Comparative tests, under actual service conditions, have *proved* that Snap-Locks last many times longer than the best available commercial grades.



Snap-Locks are positive-locking in either off or on position. Electrical and mechanical operations are separately inclosed and fully insulated. Wiring is accessible—pure silver contacts are self-wiping and arc-free—hardened steel parts—sturdy case fully protected against oil and dust. Choice of mountings and operating levers. For all normal circuits.

Send for Bulletin EM-42—with complete data on the *only* Limit Switch designed and built *by* Machine Tool Builders *for* Machine Tool Builders.

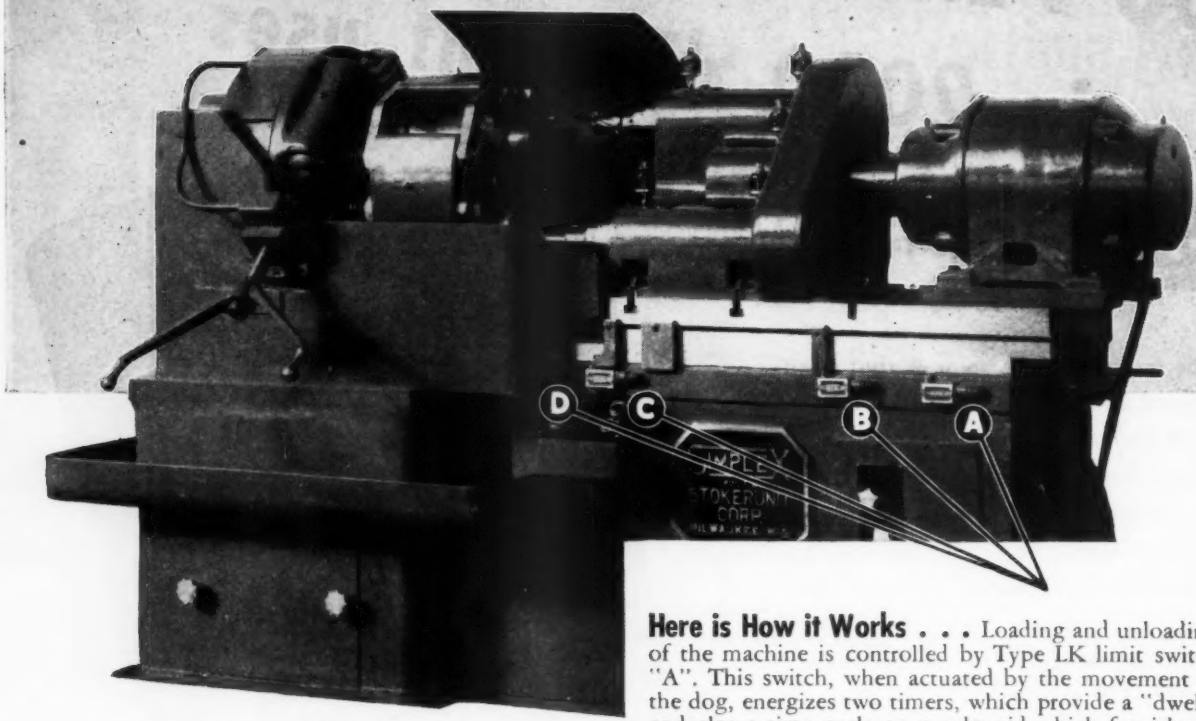
The NATIONAL ACME CO.

170 EAST 131st STREET • CLEVELAND 8, OHIO

Acme-Gridley 4-6 and 8 Spindle Bar and Chucking Automatics • Single Spindle Automatics • Automatic Threading Dies and Taps • The Chronolog • Limit, Motor Starter and Control Station Switches • Solenoids Centrifuges • Contract Manufacturing

MICRO SWITCH *Provides Automatic, Precise Operation*

FOR THIS SIMPLEX BORING MACHINE



Ruggedness and dependability of the sensitive "Micro Switch" snap-action switches is amply illustrated by their use in the automatic control of the Simplex Precision Boring and Facing Machine made by the Stoker Unit Corporation of Milwaukee, Wisconsin.

Every step in the operation of this precision machine, designed for boring and facing shells, is controlled by the use of nine switches so located as to regulate the sequence of operations of the automatic cycle.

This machine consists of a fixture and spindle head. The fixture rotates about a horizontal axis and is hydraulically indexed to four different positions in each complete cycle. The "Micro Switch" snap-action switches automatically control the feeding cycle on the table which carries the three-spindle boring head. Four of these switches are visible in this illustration.

Here is How it Works . . . Loading and unloading of the machine is controlled by Type LK limit switch "A". This switch, when actuated by the movement of the dog, energizes two timers, which provide a "dwell" and also a time cycle on a solenoid which furnishes a return to the table.

Steel clad switch "B" controls the limit of the return table travel after the boring cycle is completed.

As the head travels up to the work, the dog trips steel clad switch "C" which opens to de-energize a solenoid allowing a coarse feed travel. At the completion of the coarse feed travel, a dog contacts steel clad switch "D" which closes to energize another solenoid giving a fine feed travel.

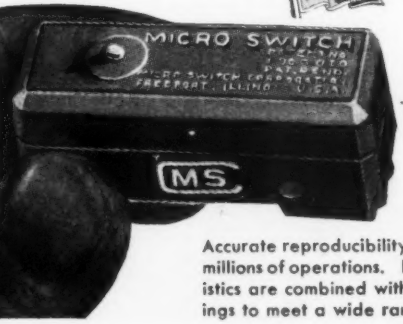
Five other switches, not visible, control operations of the spindle motor and the coolant pump and regulate the speed of operation.

Do You Need a Switch To . . . control temperatures, help to package products, bottle fluids, record airplane flights, make change, dispense drinks, heat water, control electronic tubes, or steer ships? "Micro Switch" snap-action switches successfully control many such operations . . . and thousands more. "Micro Switch" engineers, experienced in the application of millions of these precise, snap-action switches to products for both war and peace, will be glad to show you how they can add long life and reliability to your product at lower cost. Write for the "Micro Switch" Handbook-Catalog today.

LET'S ALL BACK THE ATTACK *BUY EXTRA WAR BONDS*

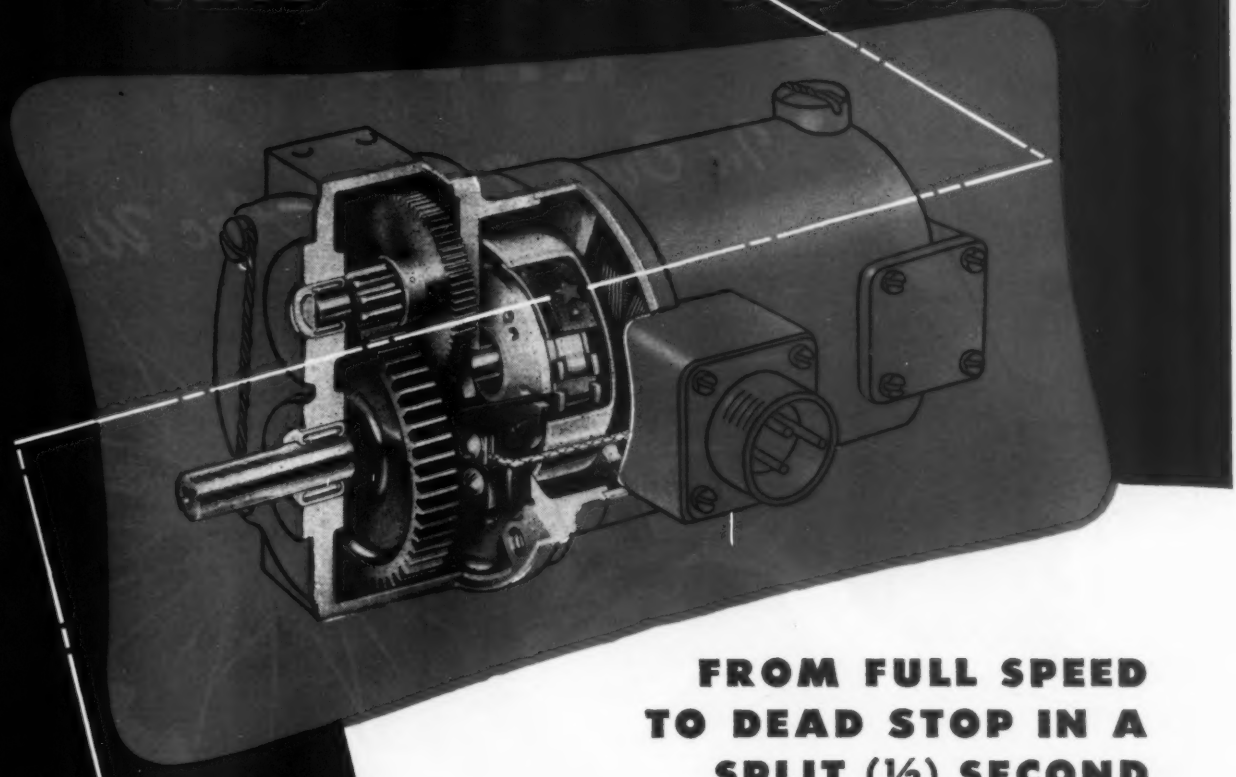
© First Industrial Corporation

MICRO MS SWITCH
TRADE MARK
A DIVISION OF FIRST INDUSTRIAL CORPORATION
Freeport, Illinois, U. S. A., Sales Offices in Principal Cities



The basic switch is a thumbsize featherlight, plastic enclosed, precision snap-action switch. Underwriters' listed and rated at 1200 V. A., at 125 to 460 volts a-c. Capacity on d-c depends on load characteristics. Accurate reproducibility of performance is maintained over millions of operations. Basic switches of different characteristics are combined with various actuators and metal housings to meet a wide range of requirements.

A GOOD BRAKE GAVE THIS MOTOR ITS START!



FROM FULL SPEED TO DEAD STOP IN A SPLIT (½) SECOND

Developed specifically to actuate the inter-cooler door of a high altitude fighter plane, this Dumore motor can be brought to a full stop in ½ second by its built-in magnetic brake. Near-perfect control of motor operation protects parts of the driven device against overrunning and jamming, thereby slashing maintenance costs and maintaining an uninterrupted operating efficiency. Successful brake design gave the motor a good start in life. But it really proved its mettle in punishing months of war duty which revealed the motor's absolute operating dependability thru endless hours of unfaltering performance. Compact and accurate controls ... space and weight economy ... steadfast service ... these characteristics of Dumore Motors may be the very answer to your product design problems. Motor-plan your product with The Dumore Company, Motor Division, Racine, Wisconsin.

OTHER DUMORE FEATURES

- GEAR REDUCTION UNITS
- AUTOMATIC LIMIT SWITCHES
- MAGNETIC CLUTCHES
- OVER-RUNNING CLUTCHES
- THERMAL OVERLOAD PROTECTORS
- POSITION INDICATING POTENTIO-METERS

IT DOES MORE BECAUSE IT'S A

DUMORE

Send for your free "Motor Selector" Today!

HEADQUARTERS FOR FRACTIONAL HORSEPOWER MOTORS

OHMITE RHEOSTATS

In Over 75% of Arc Welders

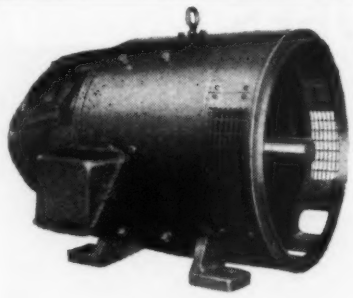
● SMOOTH, CLOSE WELDING CONTROL
for Shipbuilding and Other Vital War Work

Most American ships built since Pearl Harbor have been welded with Ohmite equipped arc welders. That's because manufacturers of welding equipment know how well they can depend on Ohmite Rheostats to give accurate, smooth, close control . . . under toughest operating conditions. These rheostats are also extensively used in the control of many other electrical and electronic devices. They are made in a wide range of types and sizes . . . with uniform or tapered windings . . . to meet every need.

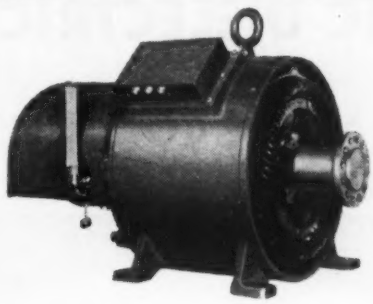
OHMITE MANUFACTURING CO.
4819 FLOURNOY ST., CHICAGO 44, ILL.

Write on company letterhead for Industrial Catalog and Engineering Manual No. 40. Address Ohmite Mfg. Co., 4819 Flournoy St., Chicago 44.

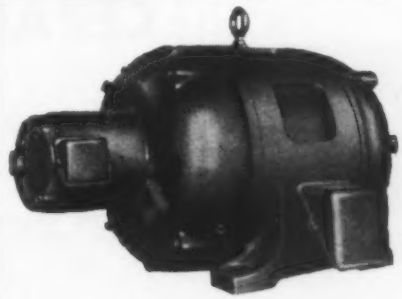
Be Right with OHMITE
RHEOSTATS • RESISTORS • TAP SWITCHES



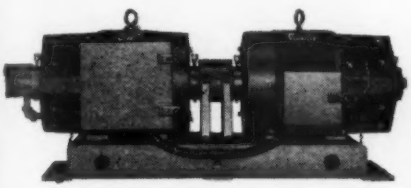
Service C. Engine Generator—Drip Proof—30 KW Direct Current.



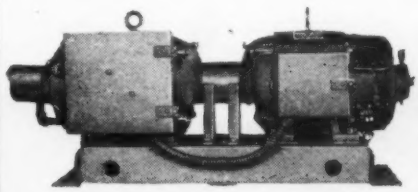
Service A. Engine Generator—Drip Proof 100 KVA Alternating Current.



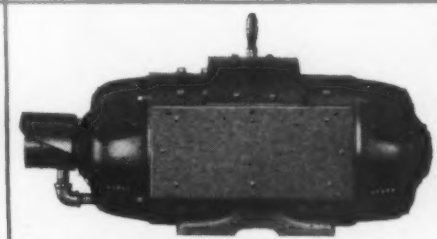
Service C. Generator 30 KVA Alternating Current.



4 KVA 4 Bearing Motor Generator Set. Service A. Converting From DC to AC, Fabricated Steel Construction.



2 KVA 4 Bearing Motor Generator Set. Service A. Converting From DC to AC, Cast Steel Construction.



.75 KVA 2-Bearing Motor Generator Set. Service C. Converting From DC to AC.

CENTURY GENERATORS and MOTOR GENERATOR SETS Supply Power with the Current and Voltage You Need . . . *Where You Need It*

There's a complete line of Century AC and DC motors that meet Navy and Maritime Service specifications A, B, and C. Thousands of them are withstanding the toughest kind of wartime service.

Century engine driven generators are supplying power to meet Navy and Army requirements.

Century motor generator sets are converting AC current to DC — DC to AC — or one DC voltage to another DC voltage to meet the requirements of special jobs such as communication, detection, fire control, and other auxiliaries.

There's a complete line of these Century special service generators and motor generator sets to meet practically any specification.

Call in a Century Application Engineer to assist you in selecting the correct Century generator or motor generator set.

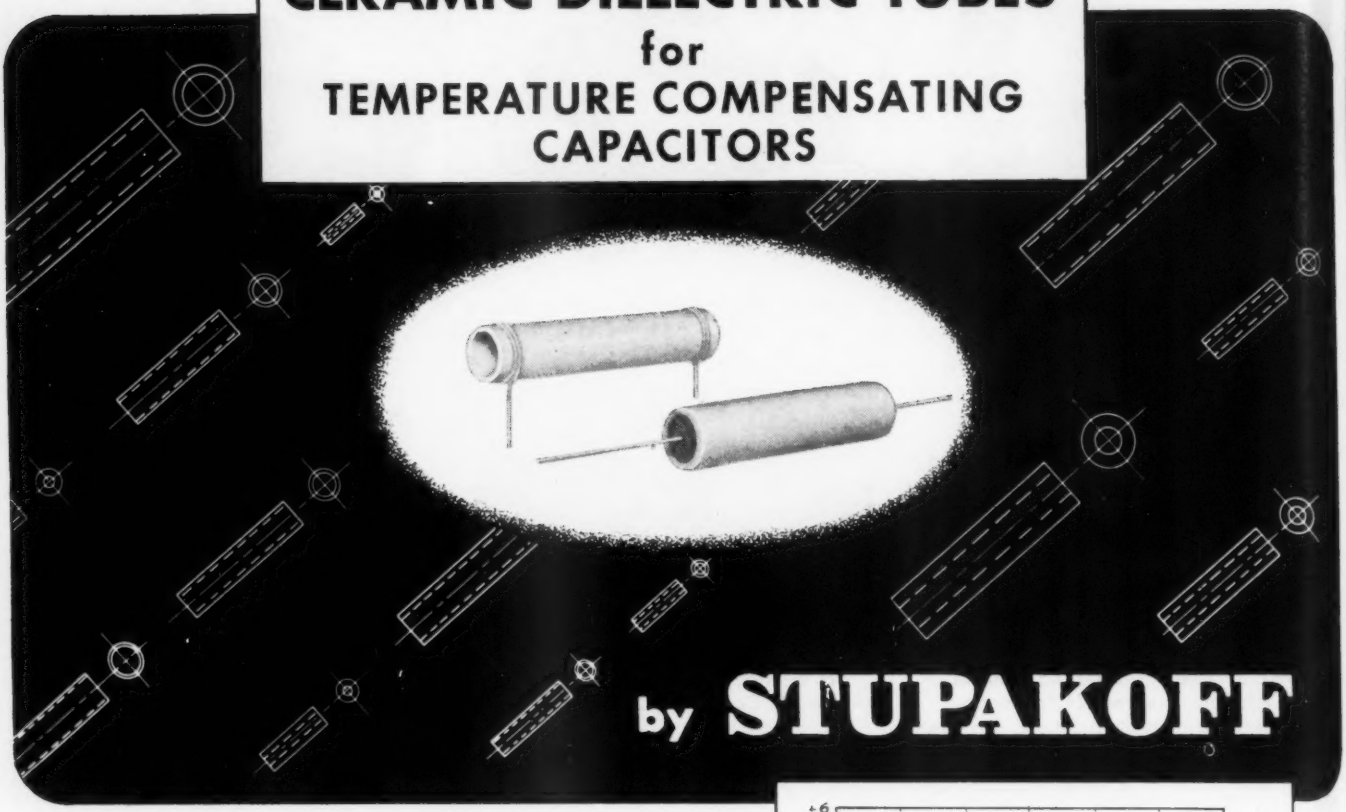
Century C MOTORS

386

CENTURY ELECTRIC COMPANY, 1806 Pine Street, St. Louis 3, Missouri

Offices and Stock Points in Principal Cities

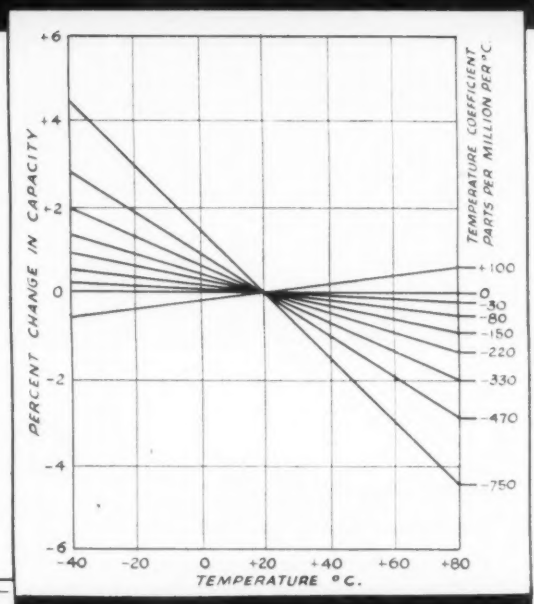
CERAMIC DIELECTRIC TUBES
for
TEMPERATURE COMPENSATING CAPACITORS



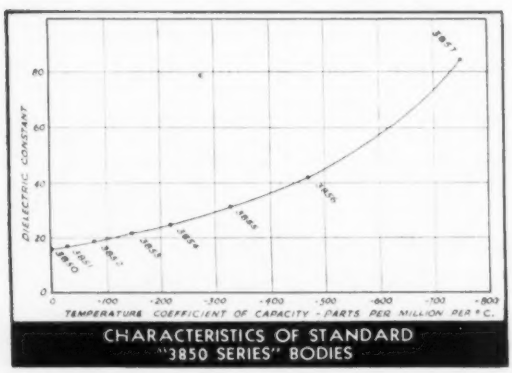
by STUPAKOFF

Stupakoff ceramic dielectric tubes have high dielectric strength, good power factor (less than 0.06%) and uniform electrical characteristics. They are available in all temperature coefficients from +120 to —750 parts per million per degree Centigrade. These tubes are employed in temperature compensating capacitors for eliminating frequency drift in RF circuits—also for bypass, lead-through and blocking capacitors.

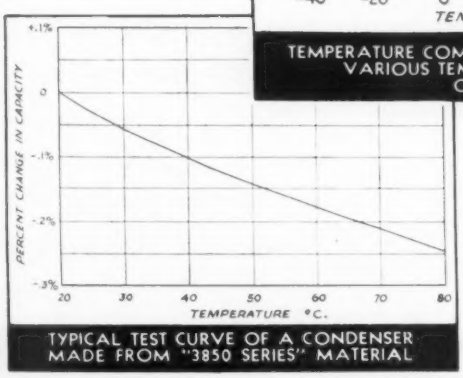
Stupakoff manufactures a wide variety of ceramic dielectric materials. Inquiries are invited for Stupakoff ceramic dielectric tubes of the 3850 series used to produce capacitors in accordance with J. A. N. specification C-20, and also for those having special electrical characteristics. Stupakoff is prepared to give prompt delivery in large quantities, of ceramic dielectric tubing in a complete range of sizes and coefficients. Your inquiries —whether for specialized or standard ceramic dielectric tubes—will receive prompt attention.



TEMPERATURE COMPENSATION OBTAINED WITH VARIOUS TEMPERATURE COEFFICIENTS OF CAPACITY



CHARACTERISTICS OF STANDARD "3850 SERIES" BODIES



TYPICAL TEST CURVE OF A CONDENSER MADE FROM "3850 SERIES" MATERIAL

RADIO MANUFACTURERS ASSOCIATION MEMBER RMA

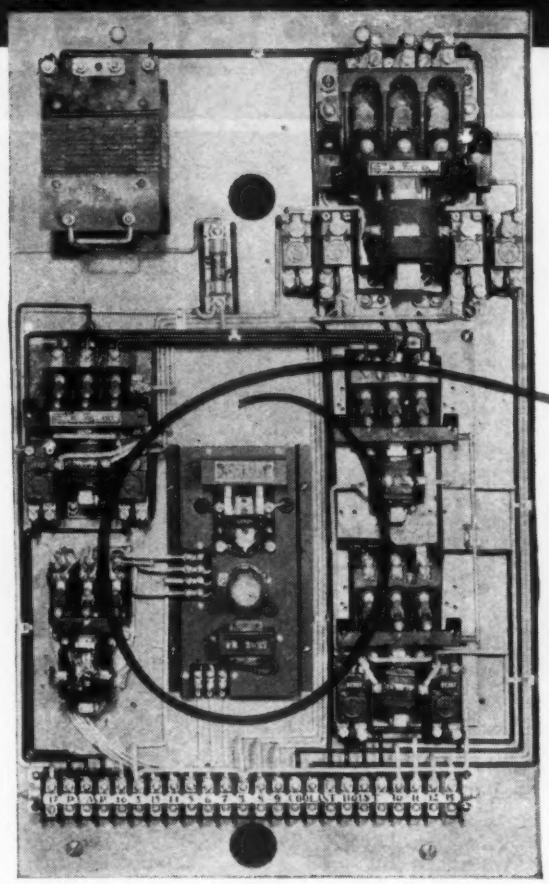
BUY MORE WAR BONDS

ARMY NAVY "FOR GREAT ACHIEVEMENT"

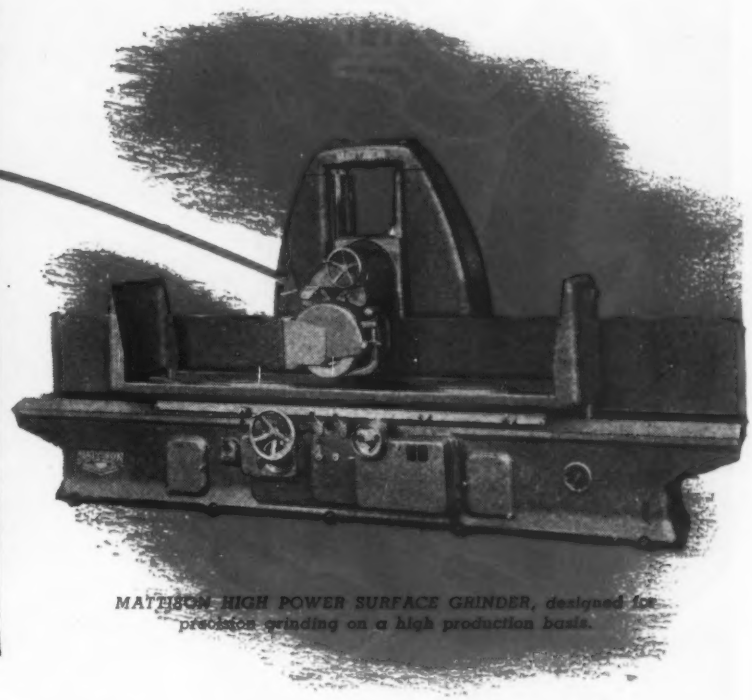
STUPAKOFF CERAMIC AND MANUFACTURING CO., LATROBE, PA.

Ceramics for the World of Electronics

MATTISON ATTAINS NEW HIGHS in PRODUCTION and PRECISION with "3C" ELECTRONIC CONTROL



"3C" Control Panel for Mattison Grinder, with Electronic Timer (circled in red) to time the travel of the cross-feed.



MATTISON HIGH POWER SURFACE GRINDER, designed for precision grinding on a high production basis.

● The new Mattison Precision Surface Grinder typifies machine tool engineering at its best—high power, wide range, large capacity, production speed, ruggedness and such extreme accuracy that it can be used on many jobs formerly hand scraped.

Control for such a machine is vitally important. The operation of the 4 motors, ranging from ¾ to 30 H.P., presented no particular problem. Control equipment consists of individual magnetic starters providing overload and undervoltage protection for each motor, with control transformers and relays installed in a dust-proof cabinet.

But the application of the "3C" electronic timer reflects the ingenuity of the tool designer, cooperating with Clark engineers. Bulletin 7313 type ET 20 Electronic Timer is specially designed to time the travel of the cross feed. Entirely automatic, it has a time range of 1/10 to 1 second, providing wheel feeds adjustable to width of wheel. It is designed for 40 operations per min., 24 hrs. a day. Timer has only one tube and few moving parts—enabling it to operate millions of times with minimum maintenance.

Clark specializes in controls for modern, high speed machine tools. Let Clark engineers help you design the proper controls for your equipment.

THE CLARK CONTROLLER CO.

1146 EAST 152nd ST., CLEVELAND 10, OHIO • OFFICES IN PRINCIPAL CITIES

EVERY FRACTIONAL HORSEPOWER MOTOR HAS A BRUSH PROBLEM

. . . and here's why

A fractional horsepower motor brush for use on 110 V. requires an entirely different composition of ingredients than one to be used on a similar motor but, say, for 6 V. operation. Again, a brush that may do very well on one make or type of vacuum cleaner will be regarded as only mediocre on another—even though the points of electrical or mechanical difference are so small as to seem unimportant.

Almost without exception, small motors differ in their brush requirements. Even a slight difference in the "mix" of a brush may—and often does—make a whale of a difference in its life or performance. Emphasis on long life, or quiet operation, or minimum commutator wear, or various other factors should all be considered—*and in the light of the specific application!*

Backed with unparalleled experience in the production of more small motor brushes for more applications than any other manufacturer, Stackpole engineers are in an enviable position to help you in this all-important respect. Moreover, for 25 years, it has been their practice to have customers send their equipment to our laboratories. Thus, Stackpole brush recommendations are made NOT by guesswork, but on the sound basis of exhaustive tests on the actual equipment.

HEADQUARTERS FOR MOLDED CARBONS, GRAPHITES, METALS, AND COMPOSITIONS

Brushes and Contacts (All carbon, graphite, metal, and composition types)

Rare Metal Contacts

Bearings Welding Carbons

Packing, Piston and Seal Rings

Continuously Adjustable Carbon Rheostats

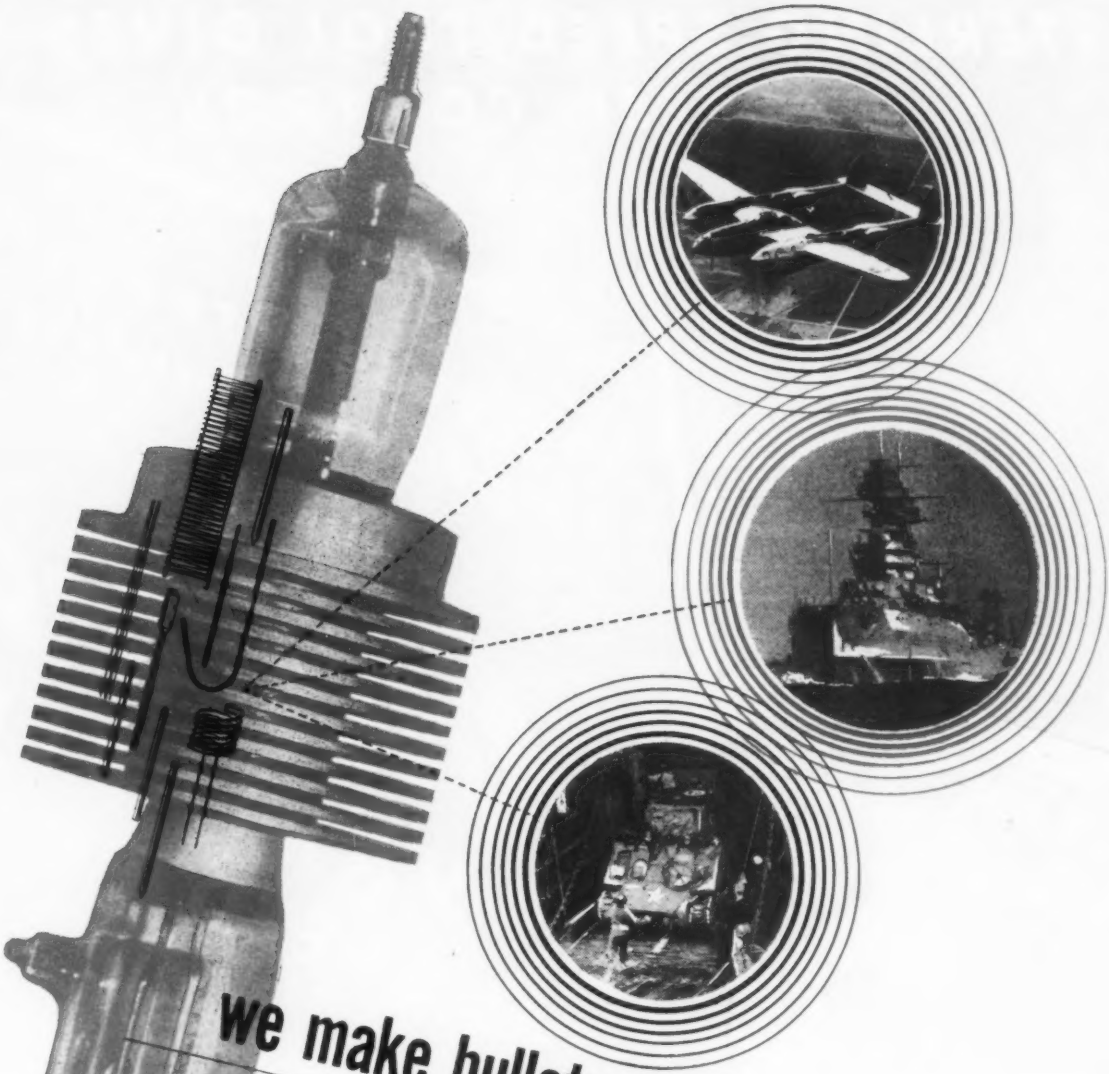
Sintered Iron Components

Fixed and Variable Resistors, etc., etc.

STACKPOLE CARBON COMPANY, St. Marys, Pa.

STACKPOLE

THE NATION'S LARGEST PRODUCER OF SMALL MOTOR BRUSHES



we make bullets for this killer....

Electron tubes make possible the moment-to-moment information so vital to the success of our fighters' operations in the air, on land and sea. The working parts of these tubes are ammunition that speeds death to the enemy as surely as the bullets and shells they direct.

A new and unique tube is the N. U. Type 8011 . . . a "must" for a certain type of high-powered, high-frequency transmitter. Callite has long supplied National Union Radio Corporation with precision-engineered tube components. It was only natural that we were called on to supply essential elements for the NU 8011 Tube.

Callite processes tungsten wire in seven types for the requirements of electron tubes and lamps. Through years of research, we have perfected a special high thoria content tungsten filament for radio receiving and transmitting tubes. Callite thoriated filament gives long life, with constant, dependable electron emission, even under unusually heavy load conditions.

•

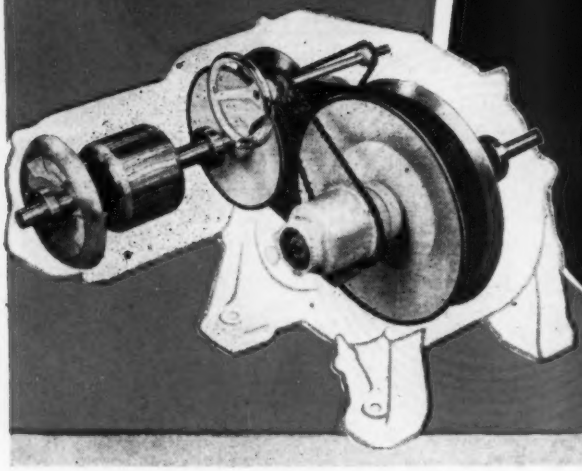
Metallurgical components have been our specialty for over 25 years. We are supplying the leaders of the Electronic Industry. It will pay you to investigate our complete range of tungsten and molybdenum products. Callite Tungsten Corporation, 551 Thirty-ninth St., Union City, N. J. Branch Offices: Chicago, Cleveland.

Callite *tube components*

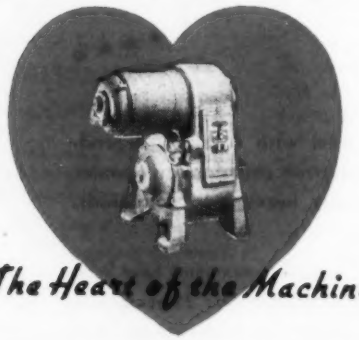
Hard glass leads, tungsten and molybdenum wire, rod and sheet, formed parts, and other components for electron tubes and incandescent lamps.

STERLING SPEED-TROL GIVES YOU SPEED CONTROL

Increase Production Improve Quality with this built-in VARIABLE SPEED POWER



STERLING SPEED-TROL MOTORS



The Heart of the Machine

A revolutionary design of infinite variable speed, varying from 2:1 to 6:1. ¼ to 15 H.P.

Sterling System Speed-Trol Units are compact, enclosed, self-contained, infinitely variable speed power units of lasting efficiency, incorporating thoroughly tried and proven principles.

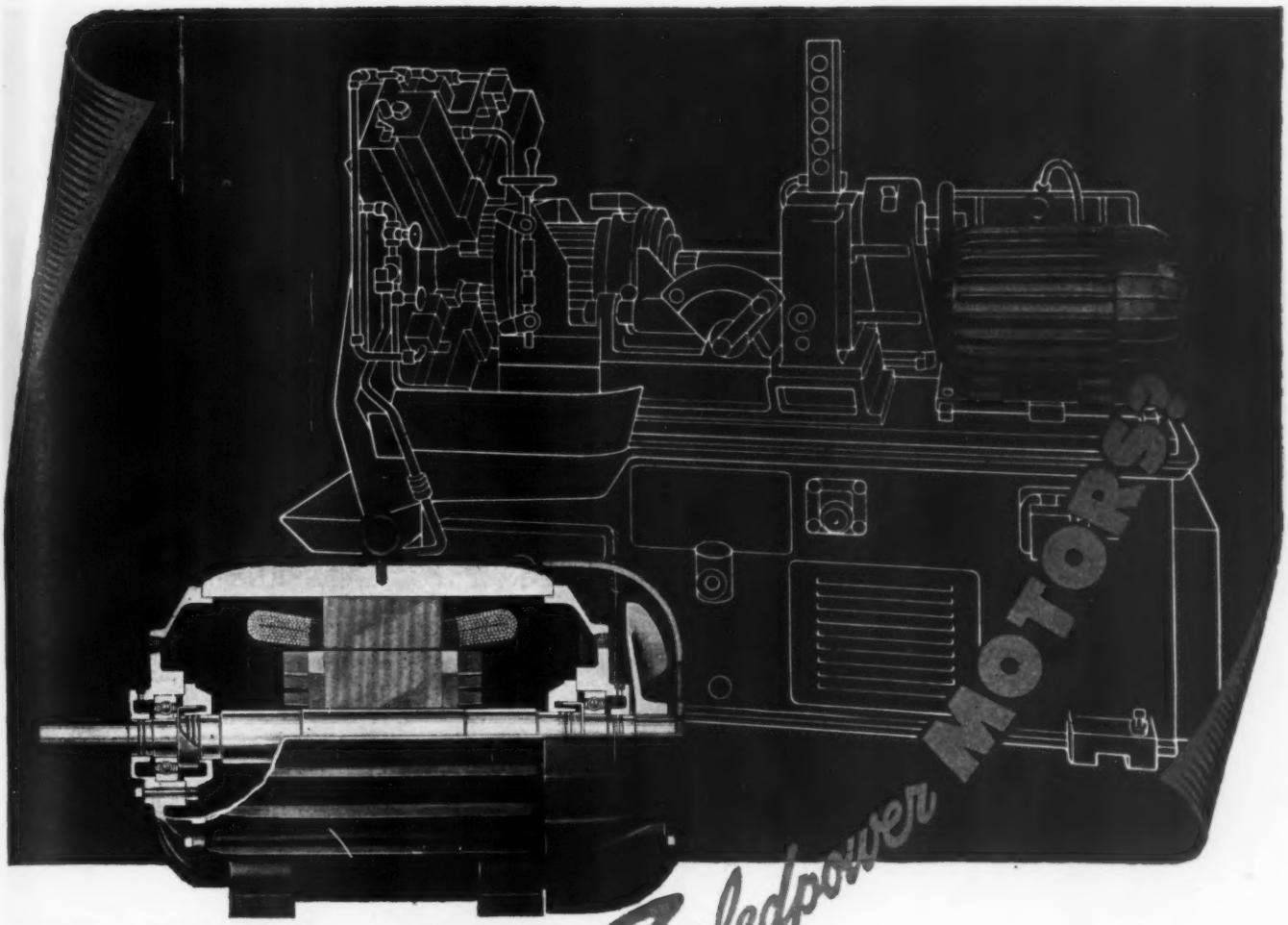
Sterling Speed-Trol Motors make available a greatly improved and inexpensive system of machine drive for all industries—will increase production — improve products — decrease production costs — are revolutionary in their simplicity, and possess features long needed but heretofore never obtainable.

Write for complete information.

STERLING ELECTRIC MOTORS, INC.
NEW YORK • CHICAGO • LOS ANGELES
REPRESENTATIVES IN PRINCIPAL CITIES

STERLING ELECTRIC MOTORS

for Greater Perform-ability (Sm)



WHY SPECIFY Sealedpower

When a motor is supplied as an integral part of a machine, the reputation of that machine is likely to stand or fall with the performance of the motor. Many purchasers link motor failure to faulty design of machine. They do not differentiate between the two.

That is why it pays to specify **SEALEDPOWER** Motors. Because these motors are *designed* to provide trouble-free operation with minimum attention.

MINIMUM ATTENTION

There are no ventilating passages in the frame to be cleaned periodically. Bearings call for re-greasing only once a year or even less frequently. These are real advantages when maintenance help is at a premium.

NO COSTLY SHUT-DOWNS FOR REPAIRS

The totally-enclosed frame protects against oil, corrosive liquids, acid and alkali fumes, air-borne moisture, steam, conducting dusts and other harmful foreign matter, preventing premature breakdown of windings. Patented grease seal for bearings retains grease. Vacuum impregnation of windings reduces hot-spot temperature, lengthens insulation life and prevents vibration of wires inside or outside of slot. Practically indestructible ALUCAST rotor construction does away with rotor trouble.

WHEN TO SPECIFY

SEALEDPOWER Motors are recommended for all applications where conventional totally-enclosed, fan-cooled types have been used in the past. Mounting dimensions conform to NEMA standards.

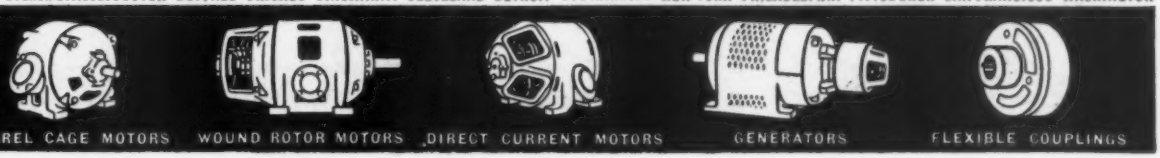
Write for complete details. No cost, no obligation.

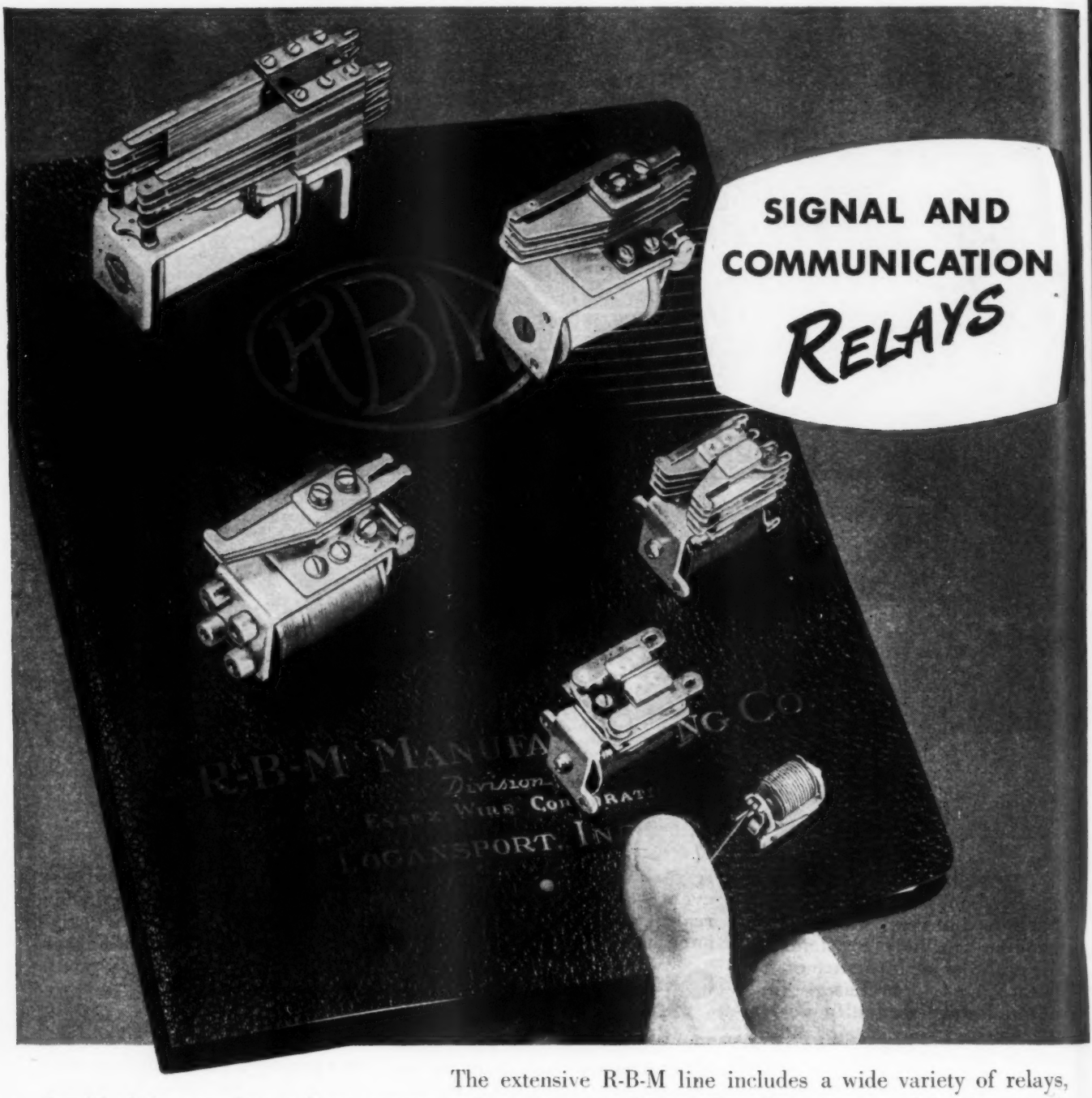
CROCKER-WHEELER

A Division of JOSHUA HENDY IRON WORKS

AMPERE, NEW JERSEY

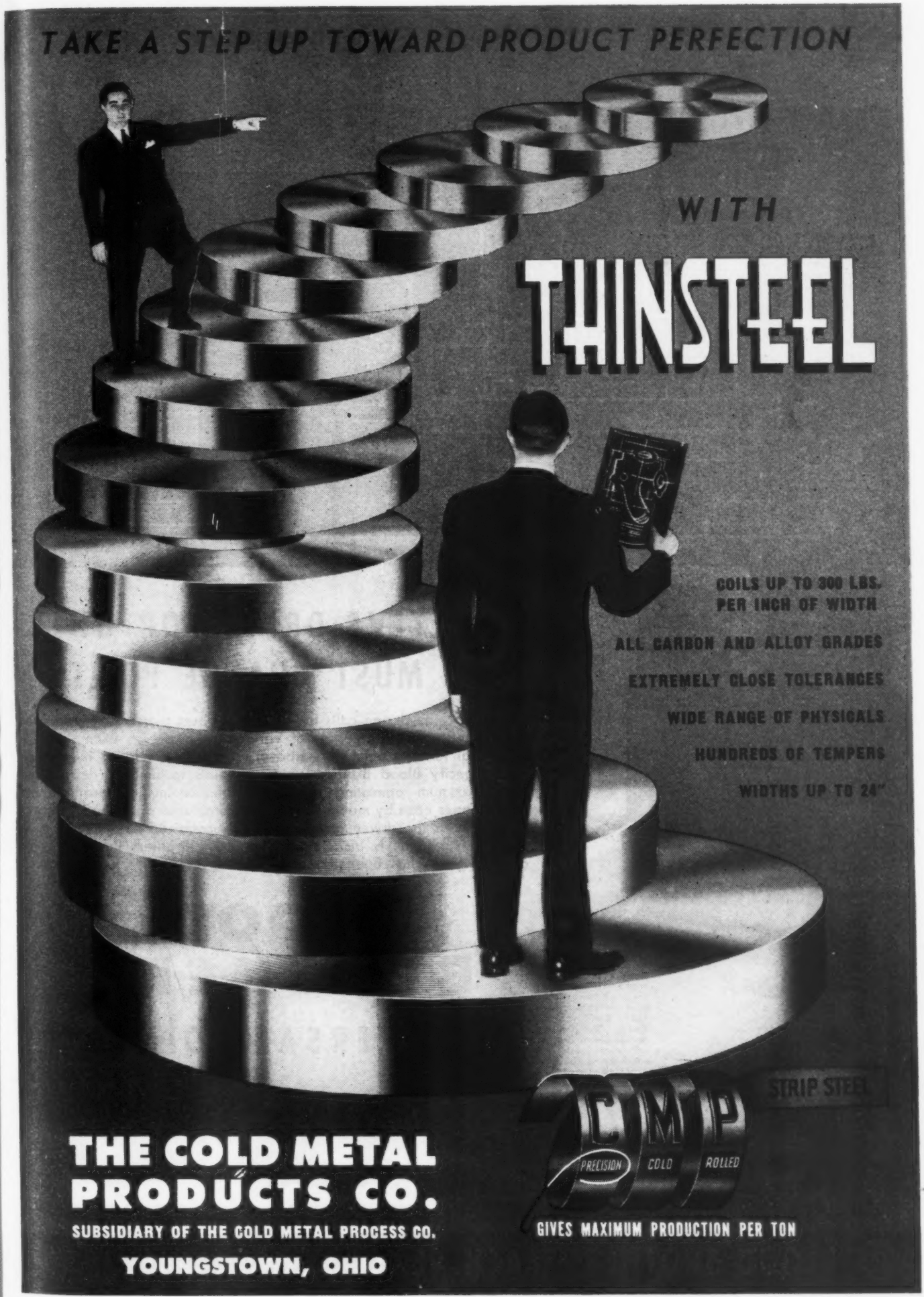
Branch Offices: BOSTON • BUFFALO • CHICAGO • CINCINNATI • CLEVELAND • DETROIT • LOS ANGELES • NEW YORK • PHILADELPHIA • PITTSBURGH • SAN FRANCISCO • WASHINGTON





The extensive R-B-M line includes a wide variety of relays, furnished in complete voltage ranges and contact capacities ordinarily encountered in the signal, electronic, and communication fields. For further information write Dept. E-4...

R-B-M MANUFACTURING COMPANY
Division of
ESSEX WIRE CORPORATION
LOGANSPORT, INDIANA


TAKE A STEP UP TOWARD PRODUCT PERFECTION
WITH
THINSTEEL
COILS UP TO 300 LBS. PER INCH OF WIDTH
ALL CARBON AND ALLOY GRADES
EXTREMELY CLOSE TOLERANCES
WIDE RANGE OF PHYSICALS
HUNDREDS OF TEMPERS
WIDTHS UP TO 24"
STRIP STEEL
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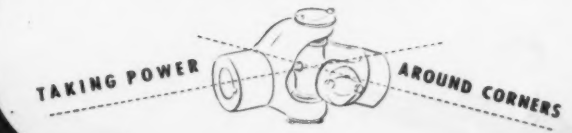
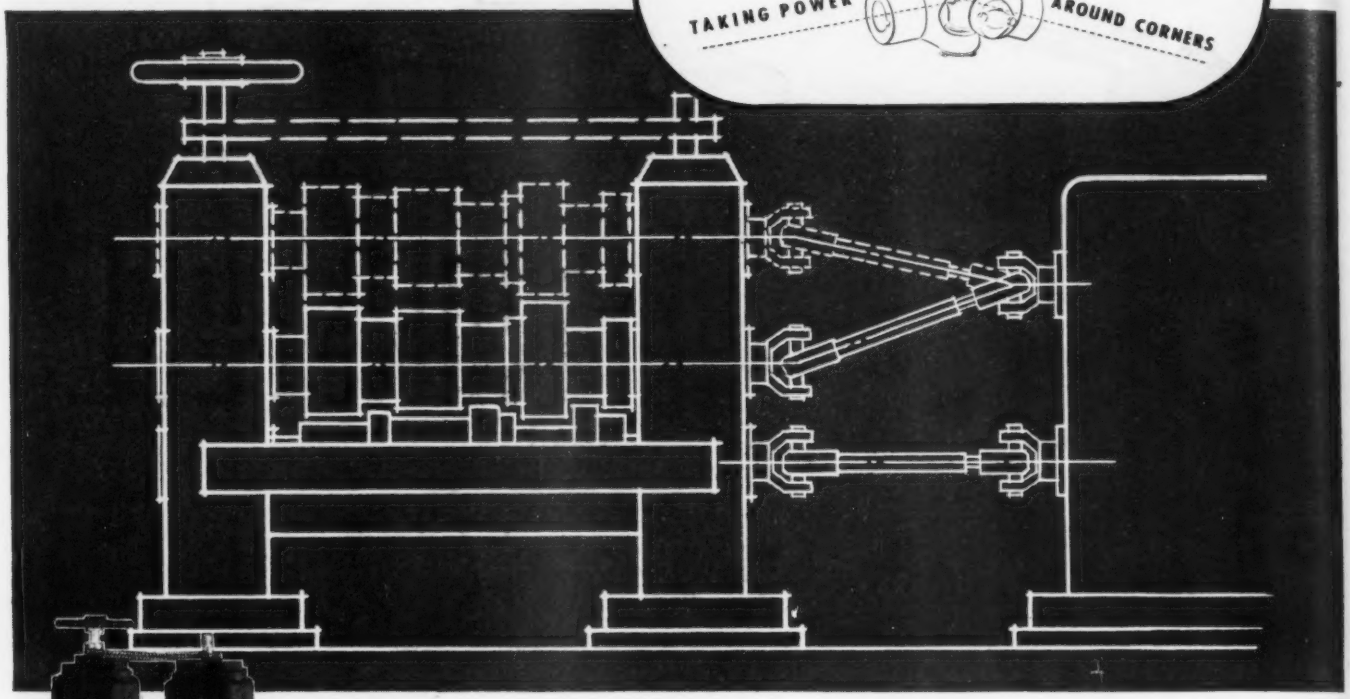
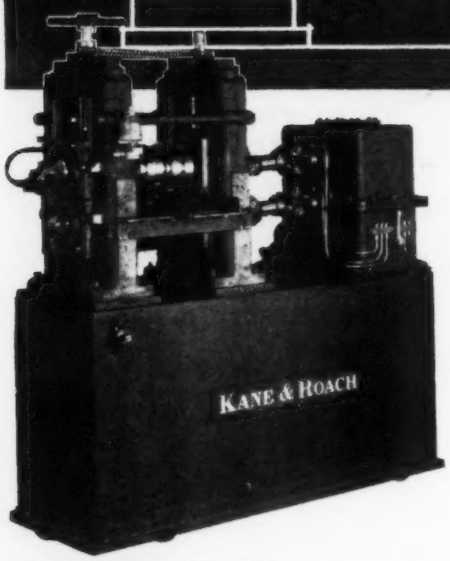
PRECISION COLD ROLLED
THE COLD METAL PRODUCTS CO.
SUBSIDIARY OF THE COLD METAL PROCESS CO.
YOUNGSTOWN, OHIO
GIVES MAXIMUM PRODUCTION PER TON

A PROBLEM IN . . .





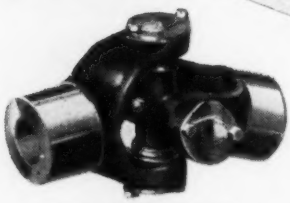


EFFECTIVE DRIVE FOR UNITS THAT MUST CHANGE POSITION

When machine design calls for driven members that must be adjusted to compensate for materials of varied thickness — as exemplified in the metal forming machinery above, rolling mills, curving machinery, etc. — specify Blood Brothers universal joints to simplify design and give maximum operating efficiency with minimum operating and maintenance costs by making possible a continuous drive that "follows" the plane of the driven member. Every recognized need in the field of universal joints is included in the Blood Brothers line which for over 30 years has been identified as one of quality and economy.

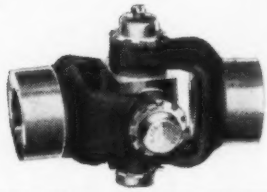
DESIGN ENGINEERS
Let our engineering staff help in your design problems of transmitting power through angularity and misalignment. FREE ENGINEERING DATA: Specifications on all Blood Brothers universal joints and engineering bulletins — write Dept. 12.

BLOOD BROTHERS
UNIVERSAL JOINTS

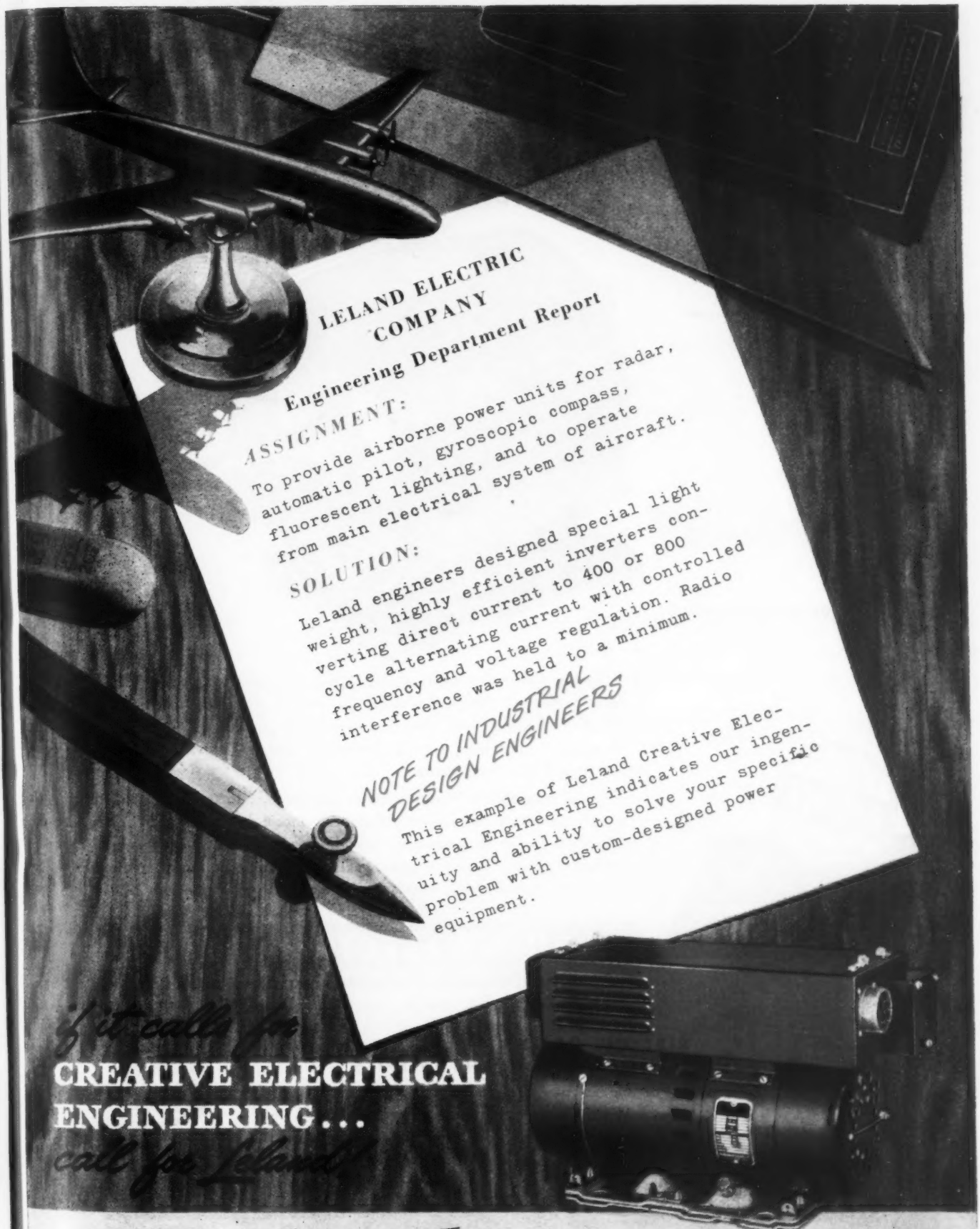

AUTOMOTIVE TYPE

CONSTRUCTION EQUIPMENT TYPE

FARM EQUIPMENT TYPE


POWERED MACHINERY TYPE

BLOOD BROTHERS MACHINE CO. ALLEGAN • MICHIGAN
DIVISION STANDARD STEEL SPRING CO.


LELAND ELECTRIC COMPANY
Engineering Department Report
ASSIGNMENT:
To provide airborne power units for radar, automatic pilot, gyroscopic compass, fluorescent lighting, and to operate from main electrical system of aircraft.
SOLUTION:
Leland engineers designed special light weight, highly efficient inverters converting direct current to 400 or 800 cycle alternating current with controlled frequency and voltage regulation. Radio interference was held to a minimum.
NOTE TO INDUSTRIAL DESIGN ENGINEERS
This example of Leland Creative Electrical Engineering indicates our ingenuity and ability to solve your specific problem with custom-designed power equipment.
if it calls for
CREATIVE ELECTRICAL ENGINEERING...
call for Leland

THE Leland ELECTRIC COMPANY

DAYTON, OHIO • IN CANADA, LELAND ELECTRIC CANADA, LTD. . . . GUELPH, ONTARIO

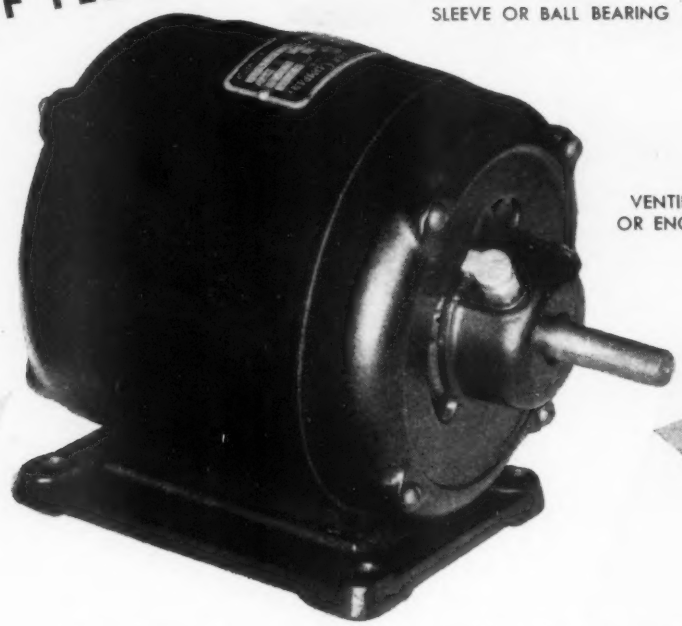
BODINE OFFERS . . .

SMALL MOTORS OF FLEXIBLE DESIGN

SLEEVE OR BALL BEARING

4-PC. HOUSING

VENTILATED OR ENCLOSED



FLOOR OR FLANGE MOUNTING

Bodine motors are popular among machine designers because they can be tailored to the job. Hence, they reduce the over-all cost of the machine. Interchangeability of frames, bases, shields, and mountings, plus the wide range of ac and dc motor ratings from 1/6 hp down to 1/2000 hp, provide versatility for every service and space requirement.

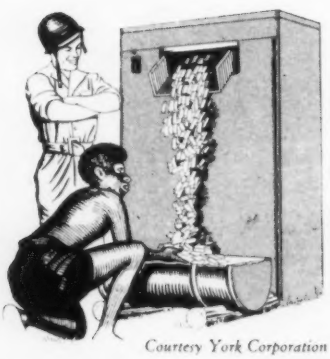
Such adaptability requires fewer castings . . . less drilling and tapping. It greatly simplifies the machine designer's motor-drive problems. These are the important factors to consider when selecting motors for your postwar power-driven devices. Call in a Bodine engineer, and make sure your motor application is correct. This engineering service is available without obligation.

BODINE

"40 years of progress"

BODINE ELECTRIC COMPANY

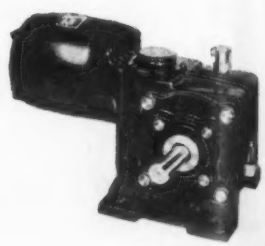
2260 W. OHIO ST., CHICAGO 12, ILL.



Courtesy York Corporation

RIBBONS OF ICE FOR OUR MEN IN THE TROPICS

Portable ice machines follow our fighting men in the tropics. Within a very short time after power and water is available, ribbons of cool, refreshing ice pour from the machine to relieve parched throats and to ease pain and shock of the injured. A small Bodine electric speed reduction motor controls the quality and texture of the ice.



Bodine Worm Gear Speed Reduction Motor

WIDEST VARIETY OF FRACTIONAL HORSEPOWER MOTORS

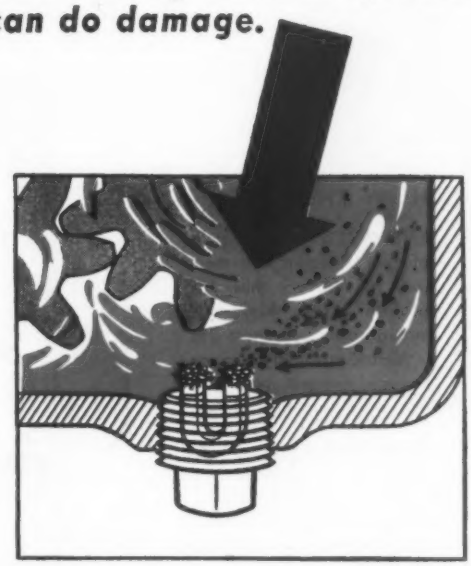
TRAPPED!

The vicious grizzly is extremely difficult to trap. Experienced trappers use a special sharp-toothed trap, 2 ft. long, with powerful double springs which hold despite the bear's enormous strength.

TRAPPED!

Dangerous, abrasive metal which forms in lubricants, due to wear. This metal is now TRAPPED and REMOVED by Lisle Magnetic Plugs, before it can do damage.

Now you can protect YOUR products against the wear caused by abrasive metal in the lubricant



Such metal flakes off all the time. These hundreds of tiny, razor-sharp metal particles cut and grind away at bearings, gears, and moving parts . . . are a major cause of premature breakdown.

You can stop this wear by using Lisle MAGNETIC Plugs instead of ordinary drain plugs. A powerful magnet in the Lisle plug TRAPS the abrasive metal . . . holds these harmful particles until wiped off. Your lubricant is kept clean, your products last longer. Lisle Plugs take the place of ordinary drain and fill plugs, cost little, retain magnetic power for 10 years. Send for full information today.

ENGINEERS, DESIGNERS — *We will gladly send you a Lisle Magnetic Plug free, for testing. Write for catalogue and testing sample.*

LISLE CORPORATION

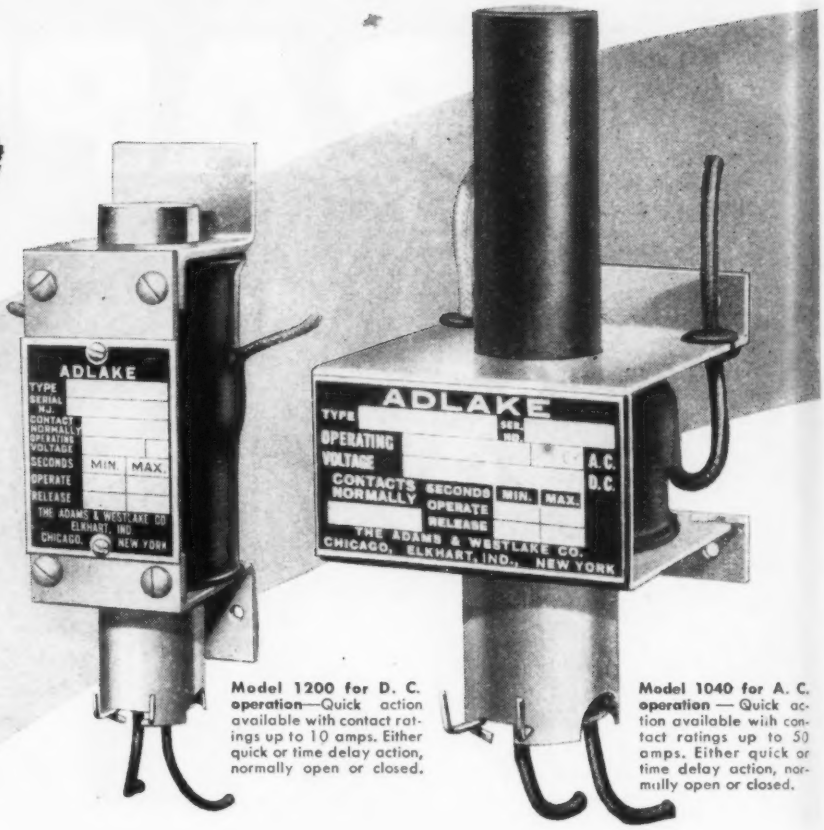
Box 1002 **Clarinda, Iowa**

Canadian Distributor, Dominion Bearings, Ltd., Toronto, Montreal, Winnipeg

Lisle Magnetic **PLUGS**

Fit right into your post-war plans!

QUICK AS A WINK!



Model 1200 for D. C. operation—Quick action available with contact ratings up to 10 amps. Either quick or time delay action, normally open or closed.

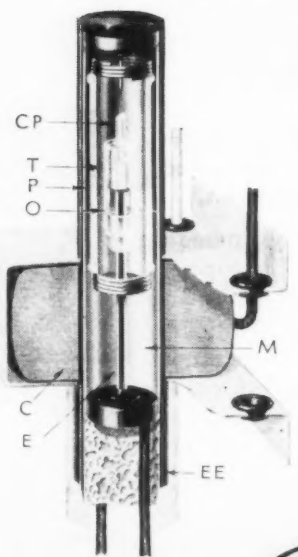
Model 1040 for A. C. operation — Quick action available with contact ratings up to 50 amps. Either quick or time delay action, normally open or closed.

Circuit Control with ADLAKE MERCURY RELAYS

HOW THEY WORK

ENERGIZED — Coil **C** pulls plunger **P** down into mercury **M**. Mercury thus displaced enters thimble **T** through orifice **O**. Inert gas in thimble gradually escapes through ceramic plug **CP**, thus producing time delay.

ENERGIZED — Mercury now fills thimble **T**, is completely leveled off and mercury-to-mercury contact established between electrodes **E** and **EE**. Degree of porosity of ceramic plug **CP** determines length of time delay.



Contacts and break-offs are as quick as a wink because Adlake Plunger-type Relays (models for A.C. or D.C.) use fast-moving, liquid metal mercury . . . positive in action, silent and chatterless; will not burn, pit, or stick.

Under the most exacting conditions . . . heat or cold, dirt, dust, or moisture they're ready and prompt to perform. Mechanisms, encased in armored glass or metal cylinders and then hermetically sealed, are impervious to the elements and oxidation.

No cleaning, no inspection, no servicing . . . relax and let an Adlake Mercury Relay work your timing, load, or control circuits—automatically and trouble-free.

Our bulletin tells the complete story, write for it today.

Adlake TRADE MARK

THE ADAMS & WESTLAKE COMPANY

ESTABLISHED IN 1857 — ELKHART, INDIANA — NEW YORK · CHICAGO

MANUFACTURERS OF ADLAKE HERMETICALLY SEALED MERCURY RELAYS FOR TIMING, LOAD AND CONTROL CIRCUITS

That's a Manufacturing Policy for

SUNLIGHT MOTORS

There is no short-cut to producing a quality electric motor. Every part and every unit must represent full measure in the quantity and quality of materials used—full measure in care and workmanship. There can be no skimping anywhere.

In the past 28 years, more than 8,000,000 Sunlight electric motors have been built—and into every motor has gone *extra* protection to safeguard its performance and give it longer wear-life. Sunlight motors, for instance, deliver up to three times their rated capacity, to give extra power during starting periods. Full-gauge copper wire is used, with extra-heavy coatings to provide better insulation on all windings. Bearings are diamond-bored, and journals are self-oiling, of cast bronze. These and dozens of other features account for the tremendous acceptance of Sunlight-powered appliances everywhere. Manufacturers and dealers know they can depend on Sunlight motors for full measure *plus*.

SUNLIGHT MOTORS FOR:

AIR COMPRESSORS
WASHING MACHINES
POWER-DRIVEN BENCH TOOLS
IRONERS
MILK SEPARATORS
MILKING MACHINES
FURNACE BLOWERS
STOKERS
OIL BURNERS
WATER PUMPS
REFRIGERATORS
VENTILATORS
AND MANY
OTHER APPLICATIONS

Packard Electric Division, General Motors Corporation, Warren, Ohio

Dependable Appliance Motors for Twenty-Eight Years

KEEP BUYING WAR BONDS

PRECISION CONTROL OF TIME INTERVALS

assured with

Paragon

PRESET TIMERS

2509 for surface mounting.

2509 for gang switch box or handy box mounting.

Paragon improved manually preset timers can be preset to perform a great variety of operations . . . to allow a given operation to continue for almost any pre-determined time limit . . . to close or open a circuit at the end of the preset time. Synchronous motor operated. Assures absolute accuracy of the timing cycle. Not affected by vibration or changes in ambient temperature. Supplied as standard with single pole, double throw switches and choice of 10 time ranges and 3 types of mounting . . . 2400 series for flush mounting, 2500 for surface mounting, 2900 for wall mounting.

Paragon Chicago

BUILDERS OF ELECTRICAL EQUIPMENT SINCE 1905

PARAGON ELECTRIC CO.

708 Old Colony Bldg. • Chicago 5, Ill.

Mr. Tops, the Paragon symbol of top quality.

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The 4th Edition of MARKS would give you greatest value and satisfaction as that book!

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2276 pages of descriptions, data, and diagrams to aid engineers, technical men, and students in the solution of mechanical engineering problems.

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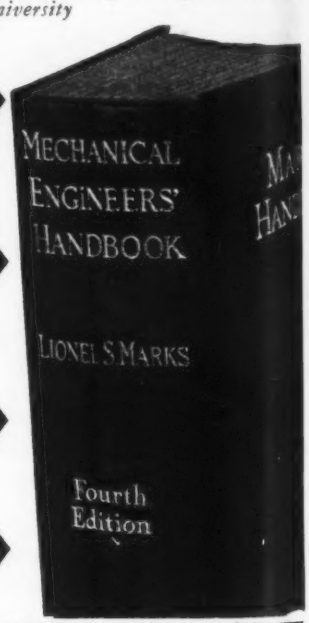

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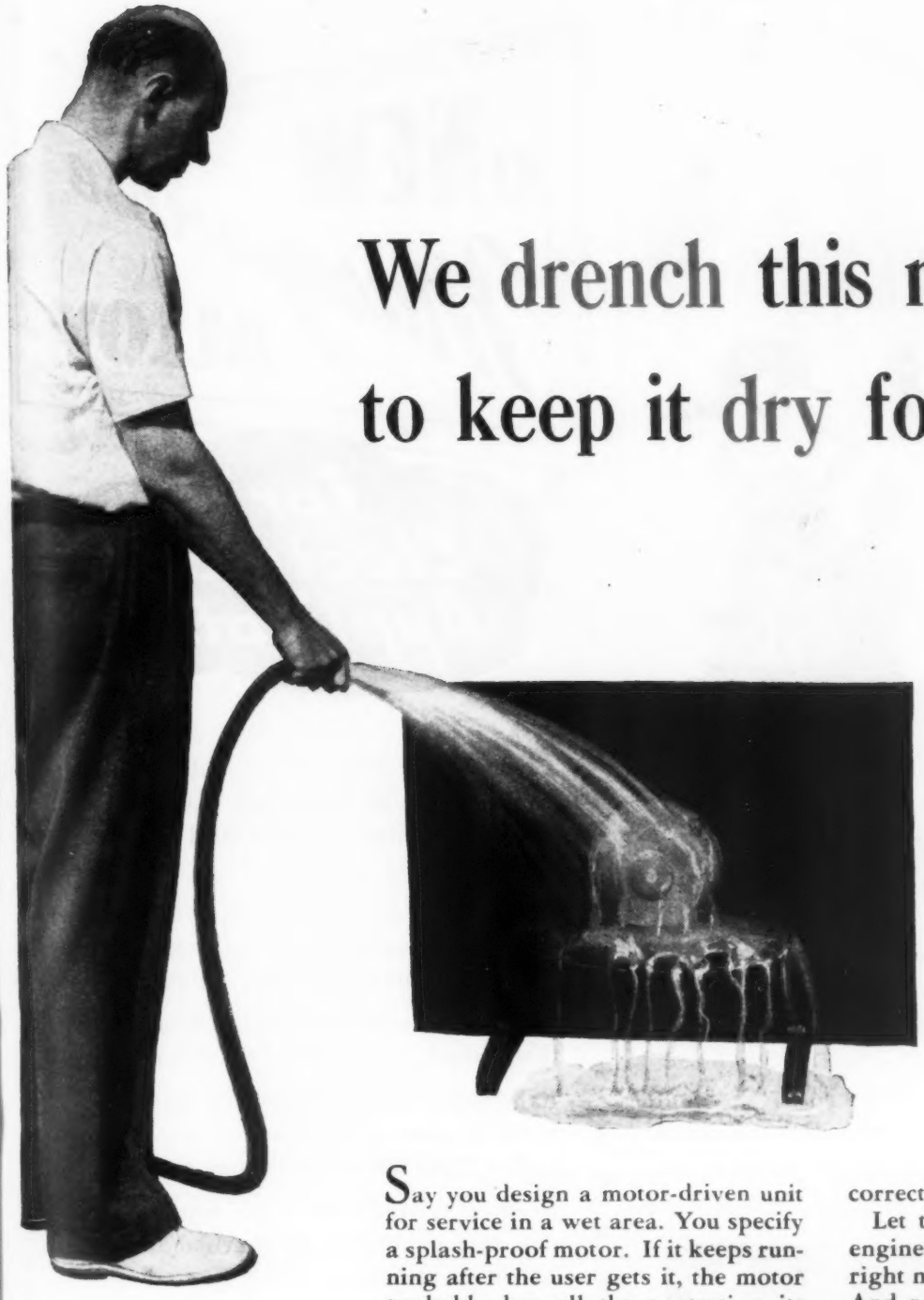


We drench this motor to keep it dry for you!

Say you design a motor-driven unit for service in a wet area. You specify a splash-proof motor. If it keeps running after the user gets it, the motor probably has all the protection its name plate implies. If it stops, well . . . you know the usual comeback, not the motor but the *unit* was poorly designed!

Knowing what you're up against, Robbins & Myers engineers take nothing for granted. They *design* Uni-Shell Motor heads to withstand the entrance of liquids reflected against the motor. And then, they *test* them with a hose under actual operating conditions to make sure that their calculations are correct, that no water gets inside.

Let this kind of "follow-through" engineering help you decide on the right model for your motor problem. And no matter which type of motor proves to be the answer, it is *interchangeable* with any other Uni-Shell Motor of the same frame size. That's something important to count on as you continually strive for design standardization.

To help you, now, an illustrated 20-page booklet (No. 1845) on R & M Uni-Shell Motors contains information you need. A copy of this fact-filled designer-aid is yours for the asking. Send for yours, today.

SHIPMENT NOW!

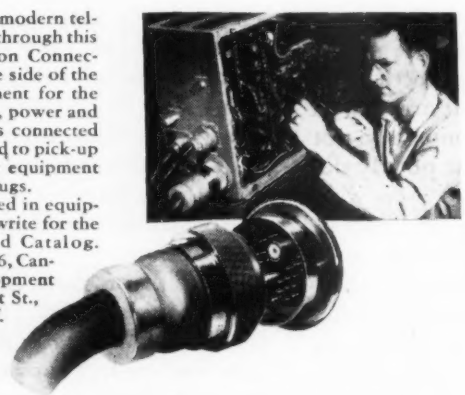
Ample stock on most types of integral motors on hand as this goes to press. Wire or phone your inquiry.

ROBBINS & MYERS • INC. MOTOR DIVISION · SPRINGFIELD, OHIO
In Canada: Robbins & Myers Co., of Canada, Ltd., Brantford, Ont.

MOTORS · HOISTS · CRANES · MACHINE DRIVES · FANS · MOYNO PUMPS · FOUNDED 1878

TELEVISION,
SINCE PIONEER DAYS, HAS DEPENDED UPON
CANNON PLUGS

Because Cannon Plugs and Receptacles were designed especially for use in critical circuits, they were incorporated into the first television hook-ups. Says Harry R. Lubcke, Director of Television for the Don Lee Broadcasting System: *"We find Cannon Connectors indispensable in our television operations. We called on Cannon in 1937 and what was probably the first all-television connector was fabricated."*



All the circuits of a modern television camera pass through this single master Cannon Connector mounted on the side of the instrument. Equipment for the control of focusing, power and intensity of image is connected to power sources and to pick-up and broadcasting equipment through Cannon Plugs.

If you are interested in equipment of this kind, write for the Cannon Condensed Catalog. Address Dept. A-106, Cannon Electric Development Co., 3209 Humboldt St., Los Angeles 31, Calif.

CANNON ELECTRIC

Cannon Electric Development Co., Los Angeles 31, Calif.

Canadian Factory and Engineering Office:
Cannon Electric Co., Ltd., Toronto, Canada

Representatives in Principal Cities — Consult Your Local Telephone Book

a NEW *Manganese* ALLOY
for Electrical Applications

Chace Alloy No. 772 provides a unique combination of properties useful to electrical equipment, control and instrument manufacturers.

Its electrical resistivity is about 60% higher than most resistance alloys in common use . . . 1050 ohms per circular mil foot.

Its thermal conductivity is less than 50% that of steel . . . only about 2% that of copper.

Its temperature coefficient of expansion is twice as great as ordinary steel . . . much higher than that of any other strong alloy.

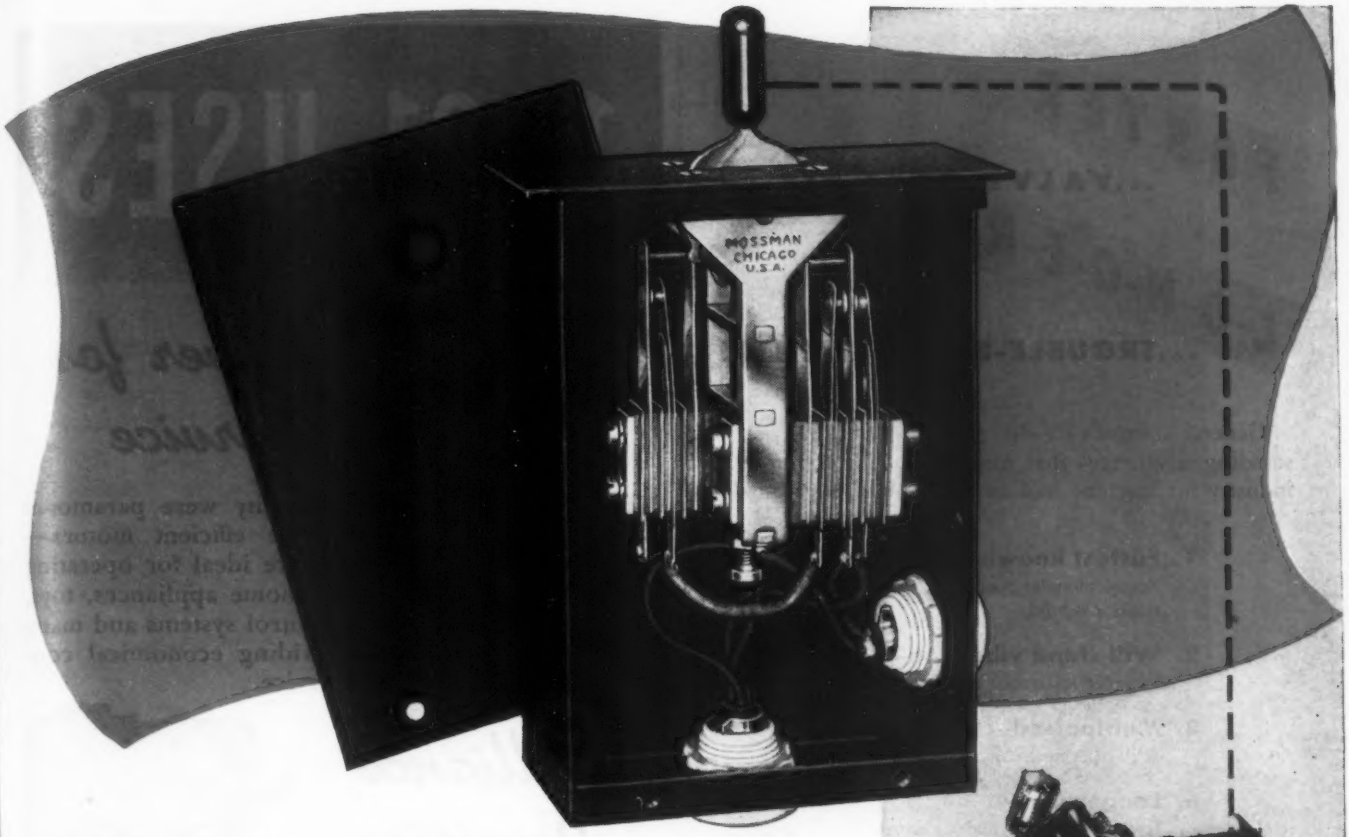
Neither its resistivity value nor its expansion rate is affected by thermal treatment . . . or by cooling to —100° F.

Chace Alloy No. 772 is non-magnetic.

This new engineering material is especially adapted to low temperature resistor applications, rheostats, auxilary heater for circuit breakers, and other electrically heated expansion elements . . . Available now in sheets, strips, and rods.

"Bulletin No. A-942", giving detailed information regarding Chace Manganese Alloy No. 772, sent on request.

W. M. CHACE CO.
Manufacturers of
Thermostatic Bimetals and Special Alloys
1607 BEARD AVE • DETROIT 9, MICH.



MOSSMAN Heavy Duty Lever Switch

Starts . . . Stops . . . Reverses

Operation of this Duplicating Machine

This duplicating machine, manufactured by the Standard Duplicating Machine Corporation of Everrett, Mass., is controlled by a Mossman Series 4101 Heavy Duty Lever Switch.

The starting, stopping, and reverse action of the machine is made possible by the use of a three position Mossman Switch which controls the operation of the fractional horsepower motor.

In this application, the Mossman Series 4101 Heavy Duty Lever Switch is supplied in a specially built steel enclosure and with the proper wiring and plugs . . . all ready to be used in the finished product.

This is typical of Mossman design and engineering service. Not only are Mossman engineers capable of supplying just the proper switch or electrical component but they will work with your engineers to design covers and wiring arrangements that will conform to your exact requirements.

The Mossman Series 4101 Switch is a heavy duty, multiple circuit, positive action lever switch. Its design affords great flexibility of circuit arrangements . . . an almost unlimited series of combinations of contact assemblies may be built up to suit specific requirements.

Constant adjustment is made certain by the heavily constructed chassis, which consists of a heavy brass frame, rigidly braced. This supports a chromium plated latch plate and spring actuated piston, in which a roller is mounted clevis fashion.

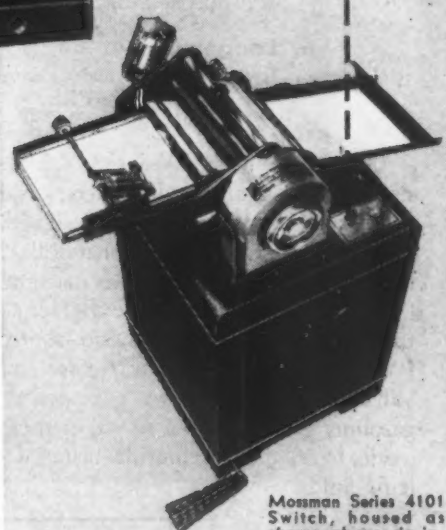
Contact ratings with standard duty contacts of $\frac{3}{16}$" fine silver are: 10 amperes, 110 volts A.C. (non-inductive). With extra heavy duty contacts of $\frac{5}{16}$" diameter silver alloy, ratings are: 20 amperes, 110 volts A.C. (non-inductive).

Consult our engineers about your switching problem. Send for the Mossman catalog which will give you full information on the Mossman line of precision electrical components.

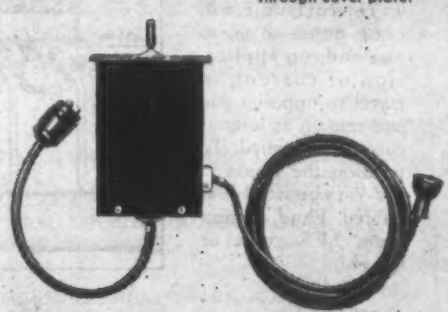
DONALD P. MOSSMAN, Inc.
612 North Michigan Avenue, Chicago 11, Illinois

MOSSMAN

Electrical Components



Mossman Series 4101 Switch, housed as shown above, is installed in this duplicating machine. Operating lever extends through cover plate.



Steel enclosed cover and complete wiring assembly is typical of manner in which Mossman switches are supplied to meet exact requirements.

FASTER ...VALVE OPERATION

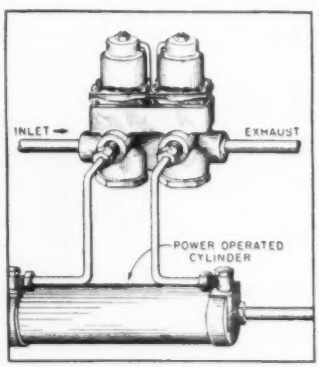
L-O-N-G-E-R ...TROUBLE-FREE VALVE LIFE

General Control's PV-Series Valves offer four outstanding advantages that make them the choice of industry for machine tool and portable applications.

1. **Fastest known valve operators—** Some models open and close hundreds of times a second.
2. **Will stand vibration—** Extreme resistance to vibratory motion.
3. **Multipoised—** Will operate in any position.
4. **Longer life—** Exclusive design and structural features provide infinitely longer life.

General Controls PV-Series Valves are a distinct departure from all previous electric valves known to industry. They are especially designed and built for portable use—for anything that rolls, floats or flies; and for severe service such as machine tool control!

The result of years of experience in building thousands of electro-magnetic control valves, the PV-Series includes accurate, dependable control valves for oil, air, water, gas, steam, fluid greases, gasoline, gasoline vapor or vapor mixes, sulphur dioxide, freon, methyl chloride, brine, alcohol and anti-icing fluids.



PV-8 Operation of hydraulic operated cylinder. This valve, on current failure, will cause piston to go to one end; on application of current, to travel to opposite end and remain as long as current is applied. To position the piston, a PV-7 type valve is offered. Fluid connections, I.P.S., tube or flanged.

If you have an automatic control problem, write nearest General Controls Factory Branch or Distributor today, or

hi-g GC

GENERAL CONTROLS

801 ALLEN AVENUE GLENDALE 1, CALIFORNIA

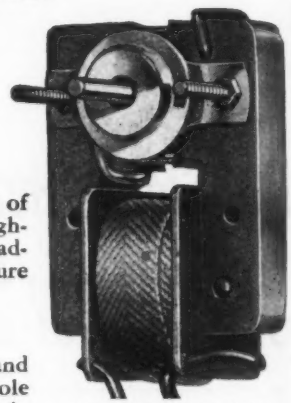
BRANCHES: ATLANTA • BOSTON • CHICAGO • KANSAS CITY • DALLAS • DENVER • DETROIT • HOUSTON PHILADELPHIA • NEW YORK • CLEVELAND • SAN FRANCISCO • *DISTRIBUTORS IN PRINCIPAL CITIES*

1,001 USES

Condensed Power for Years of Service

VERSATILITY and dependability were paramount when *Alliance* designed these efficient motors—*Multum in Parvo!* . . . They are ideal for operating fans, movie projectors, light home appliances, toys, switches, motion displays, control systems and many other applications . . . providing economical condensed power for years of service.

Alliance Precision



Model "MS"—Full Size Motor Measures 1¾" x 2 x 3⅛"

Our long established standards of precision manufacturing from highest grade materials are strictly adhered to in these models to insure long life without breakdowns.

EFFICIENT

Both the new Model "K" Motor and the Model "MS" are the shaded pole induction type—the last word in efficient small motor design. They can be produced in all standard voltages and frequencies with actual measured power outputs ranging upwards to 1/100 H. P. . . Alliance motors also can be furnished, in quantity, with variations to adapt them to specific applications.

New Model "K"—Full Size Motor Measures 2⅛" x 2⅜" x 3 3/16"

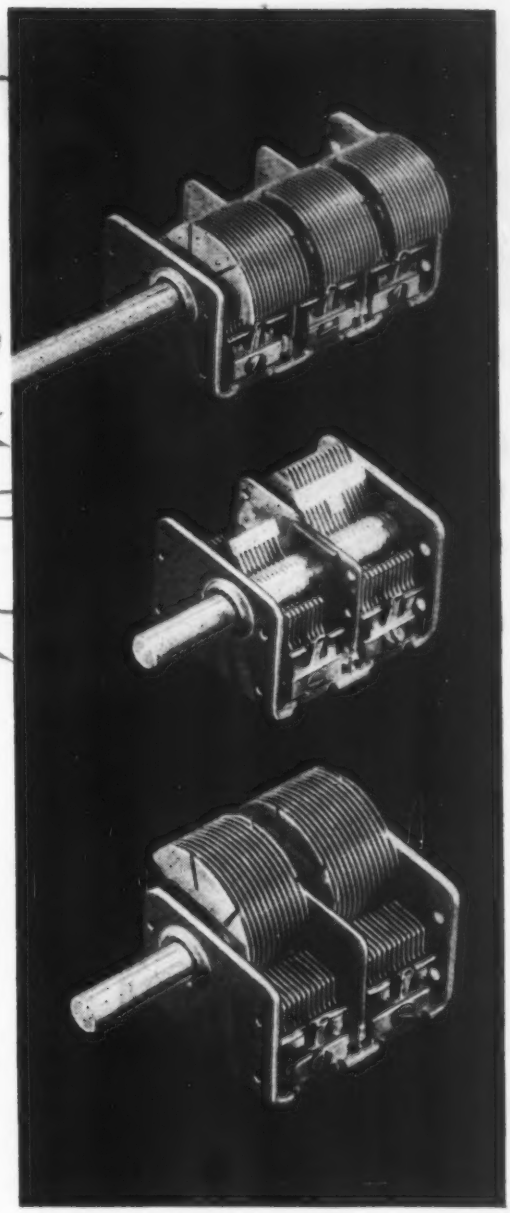
DEPENDABLE

Both these models uphold the *Alliance* reputation for all 'round dependability. In the busy post-war period, there will be many "spots" where these Miniature Power Plants will fit requirements . . Write now for further information.

Remember Alliance!
—YOUR ALLY IN WAR AS IN PEACE

ALLIANCE MANUFACTURING CO.

ALLIANCE . OHIO

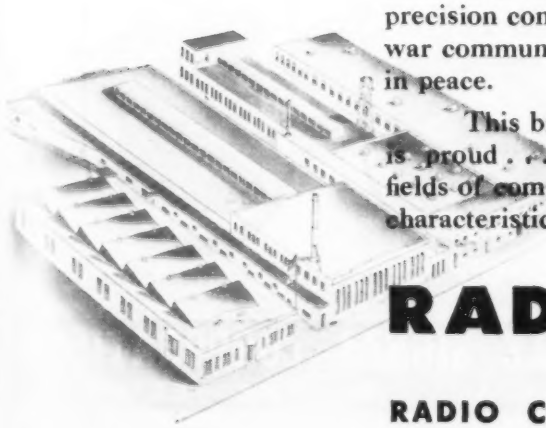


WHY R/C CAPACITORS?

FROM start to finish R/C products are researched, engineered, designed and produced by men who "*know how*"—men whose sole business is the making of better variable capacitors, *and has been for over 23 years.*

Accurate, modern methods of production make possible a precision component, produced to meet the exacting demands of war communications as well as the specifications of manufacturers in peace.

This broad background of experience is one of which R/C is proud . . . It assures leaders in the Radio and Electronics fields of components which, in every respect, match the quality characteristics they demand.



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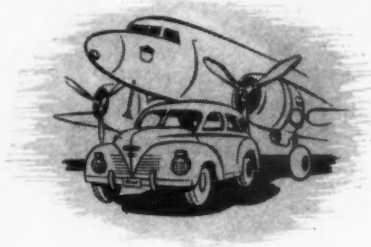
CAMDEN, N. J.

RADIO CONDENSER CO., LTD., TORONTO, CANADA

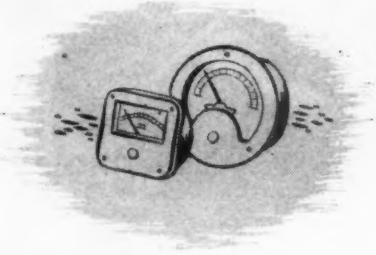
BETTER PERMANENT MAGNETS *for:*

RADIO, SOUND and COMMUNICATIONS EQUIPMENT

AUTOMOTIVE and AVIATION EQUIPMENT



INSTRUMENTS



However advanced your own product-development work may be . . . however new or revolutionary the permanent magnets you require . . . Arnold engineers can be of considerable assistance to you in supplying the proper permanent magnets *in volume.* They're precision-built entirely in our own plant, under the closest metallurgical, mechanical and magnetic control to assure peak efficiency at lowest cost.

NEW! Get your copy of this valuable, up-to-the-minute manual on the design, production and application of modern Alnico permanent magnets. Write us, on your company letterhead, today.

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*(One of the popular G-E midget heaters)**

Clamp them on pipes, valves, tanks, and warming tables; use them to construct drying cabinets; or build them into process machinery—you'll find hundreds of uses for these versatile strip heaters. They are easy to install, simple to use, and very durable. Two types are available: with steel sheath for temperatures up to 750 F; with porcelain-enameled sheath for temperatures up to 1200 F. Many sizes, very inexpensive—

PRICES FROM $2.45 SEND FOR DETAILS

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Please send me Bulletin GED-650, which describes strip heaters and other G-E midget heaters.

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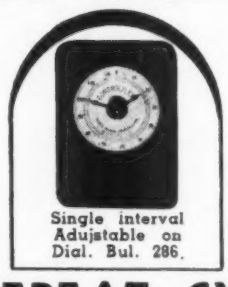
TO CONTROL MOTORS, VALVES, SIGNALS, ETC., PROVIDE AUTOMATIC OPERATION—INCREASE PRODUCTION—IMPROVE QUALITY.

ONE CYCLE RESET TIMERS



Single Interval Adjustable on Dial. Bul. 286.

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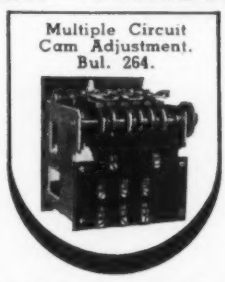
REPEAT CYCLE TIMERS

Single Circuit Dial Adjustment Bul. 265.

Multiple Circuit Cam Adjustment. Bul. 264.



EAGLE HAS A COMPLETE LINE TO PROVIDE TIMER BEST ADAPTED TO EACH APPLICATION.

EAGLE SIGNAL CORPORATION

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Blessed Event

The Howell Protected Type Motor, shown, gives complete protection against dripping liquids, metal chips and other falling particles. Completely streamlined—utilizing non-breakable steel frame—malleable or steel base—cast iron end plates and cast iron, weatherproof terminal box are standard construction features. Special horizontal and vertical mountings are available.

Available in sizes 5 H.P. and smaller. Other sizes and types available up to 150 H.P.

The reception given a new Howell Motor in any plant comes right from the heart. For when a Howell of any size or type is delivered, you can be certain of two things:

1. **Every Howell Motor is built of the finest materials, is statically and dynamically balanced, and thoroughly insulated throughout —**
2. **Our steadfast policy of maintaining pre-war standards, with no compromise in quality, is being rigidly maintained.**

Yes, we are swamped with orders today. The delivery situation in the entire electric motor industry is serious. But we fully recognize our obligations, and we are putting forth our maximum efforts to see that Howell Motors are distributed among those users whose needs are most vital to the war effort.

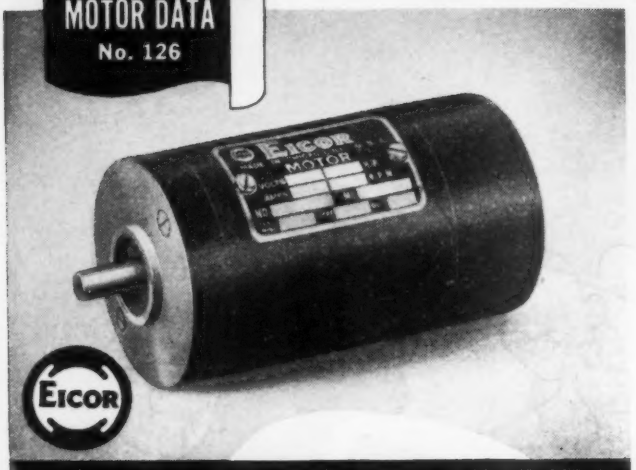
Buy Horsepower by

HOWELL ELECTRIC MOTORS COMPANY

HOWELL, MICHIGAN

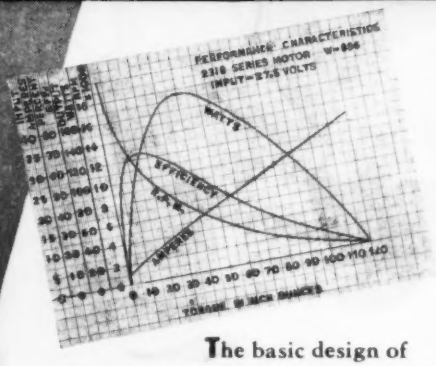
Manufacturers of Quality Motors Since 1915

MOTOR DATA
No. 126



EICOR

2300 FRAME MOTOR
1/5 HP at 3800 RPM



The basic design of the 2300 Frame Motor has been used in scores of individual modifications. Many of these designs are complete and available—others for new equipment can readily be developed.

FEATURES

ELECTRICAL

Series or shunt wound
High starting torque
Low starting current
High efficiency
Low RF interference
Unidirectional or reversible
Armature and field windings varnish impregnated and baked

MECHANICAL

Low weight factor
Unusual compactness
Completely enclosed
Base or flange mounting
Laminated field poles
Precision ball bearings
Segment-built commutator
Permanent end play adjustment

2300 FRAME MOTORS		2316 Series	2310 Shunt
Watts Output, Int.	(max.)	160	50
Torque at 6000 RPM	(in. oz.)	40	10
Torque at 3800 RPM	(in. oz.)	57	—
Lock Torque	(in. oz.)	120	14
Volts Input	(min.)	5	5
Volts Input	(max.)	110	28
Temperature Rise	(int.)	50°C	50°C
Diameter		2 5/16"	2 5/16"
Length less shaft		4 5/32"	2 3/4"
Shaft Dia.	(max.)	.312"	.312"
Weight	(lbs.)	2.4	1.5

EICOR INC. 1501 W. Congress St., Chicago, U.S.A.
DYNAMOTORS • D. C. MOTORS • POWER PLANTS • CONVERTERS
Export: Ad Auriema, 89 Broad St., New York, U. S. A. Cable: Auriema, New York

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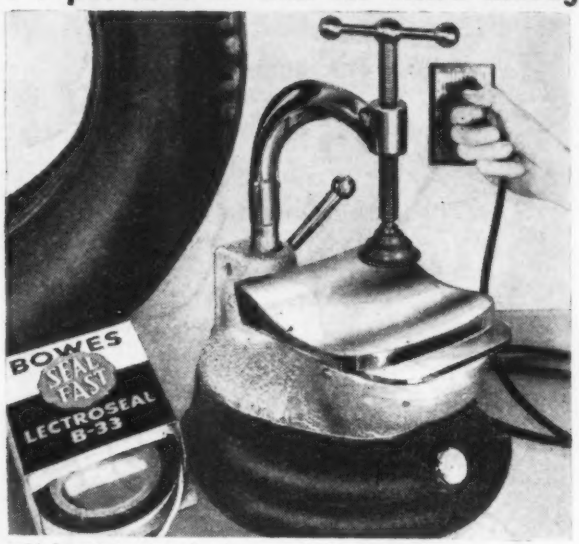
. . . put tires in trim for extra mileage



Vulcanizing is playing a vital part in the conservation of precious rubber . . . and in controlling the temperature of tire vulcanizers, THERMOSWITCHES give unparalleled performance.

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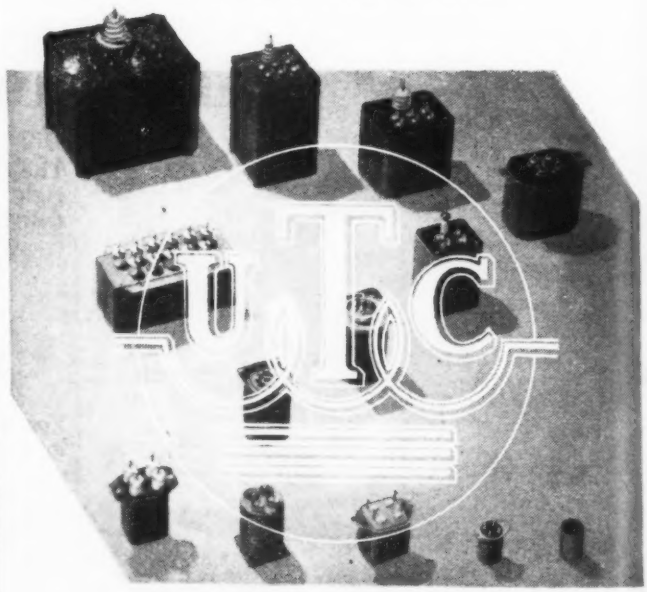
a type for every requirement



May we cooperate with you on design savings for your application . . . war or post war

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ALL PLANTS

United Transformer Corp.
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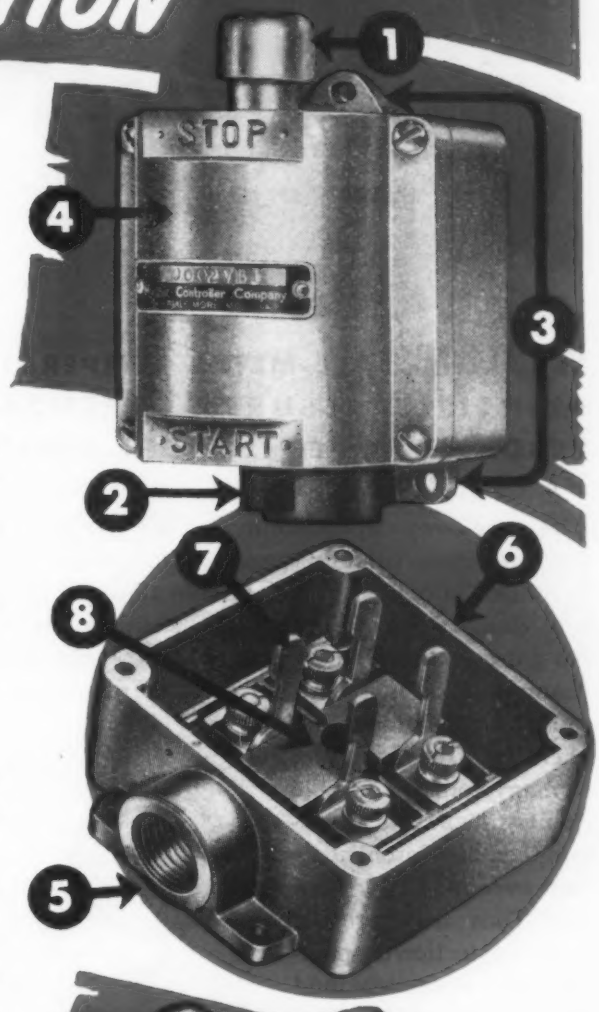
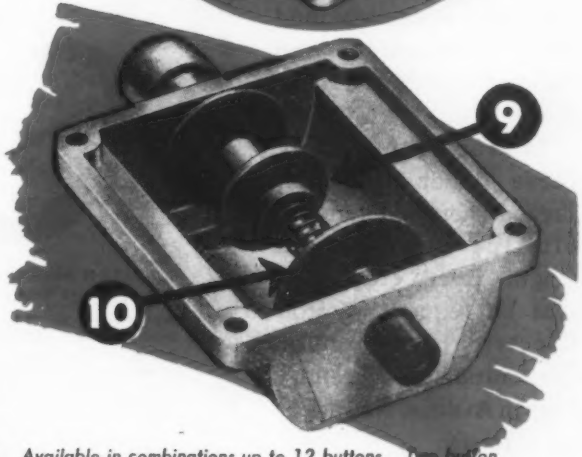
ONLY MONITOR GIVES YOU ALL THESE ADVANTAGES IN A PILOT CIRCUIT PUSHBUTTON STATION





1. "Umbrella top" stop button prevents admission of metal filings, oil, milk, other foreign materials. Metal button so positioned that operator can strike it from *anywhere* . . . with *anything* . . . will take terrific punishment. "Umbrella top" thus saves time, footsteps, helps increase production.

2. "Start" button requires uplift pressure. Thus, operator must *think* before he acts . . . With both buttons mounted vertical, dangers of careless or accidental starting or stopping are practically eliminated.

3. External mounting ears which are often an important convenience from an installation standpoint.

4. A strong die-cast enclosure which will stand up for years under the hardest kind of wear.

5. Station comes with conduit entrance already tapped for ½" conduit; no knockouts.

6. While conduit entrance is normally mounted at bottom, conduit can be accommodated from any side by simply turning the square backbox to desired position.

7. Heavy, rugged copper contacts are used throughout; are easily, quickly replaced if necessary.

8. Stationary contact block is simple to remove by means of one screw.

9. Movable contacts are free to rotate on perpendicular axis which distributes wear without loss of efficiency.

10. Insulated with Bakelite to meet Underwriters' specifications.

Make a point-by-point comparison of Monitor's heavy-duty weatherproof Type VB station with any other station designed for application where safety of operation and durability are essential. For example, machine tool or dairy operations. You'll quickly see that Monitor's VB station is safer, stronger, simpler, more versatile. Get the facts on Monitor's Type VB Pilot Circuit station now. List Price—only $4.00.

Available in combinations up to 12 buttons. Two button station illustrated measures 4¼" high, 3" wide by 2¼" deep. Tapped for ½" conduit.

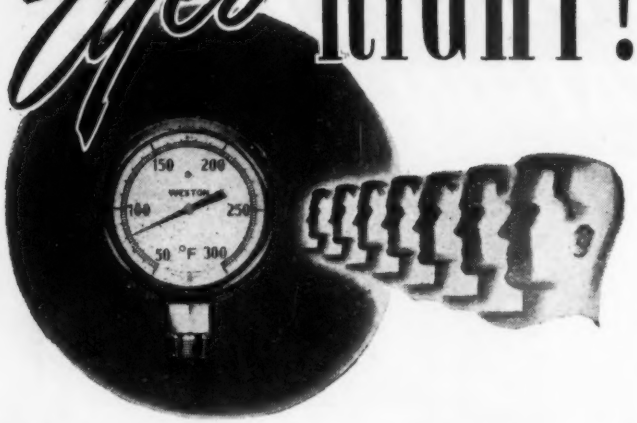
Monitor
The Original
JUST PRESS A BUTTON System

The Monitor Controller Company

GAY, LOMBARD & FREDERICK STS. BALTIMORE-2, MARYLAND

CANADIAN AFFILIATE • CANADIAN CONTROLLERS LTD. • TORONTO, ONTARIO, CANADA

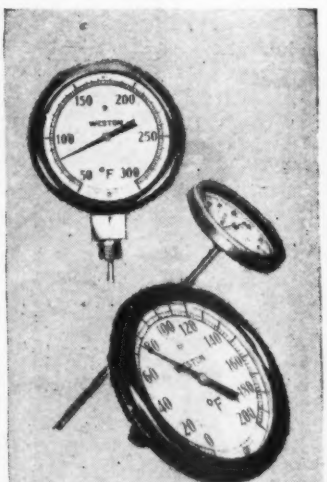
Eyes RIGHT!



WESTON'S ALL-METAL TEMPERATURE PRINCIPLE ASSURES DEPENDABLE READINGS, OVER LONGER PERIODS!

The *long-term* dependability of the WESTON thermometer stems from its rugged, all-metal construction. It consists of only a simple, durable all-metal temperature element safely encased in a stainless steel stem. No gases or liquids, no capillary, no complicated mechanical linkages, no fragile parts are employed. Because of this extreme simplicity, and the absence of so many common trouble points, WESTONS maintain their high initial accuracy *over far longer* periods. Thus they provide better protection for processes and equipment, and keep replacement and maintenance costs at a far lower level.

Literature describing these dependable and rugged thermometers, including types, stem lengths, prices, etc., gladly sent on request. Weston Electrical Instrument Corporation, 684 Frelinghuysen Avenue, Newark 5, New Jersey.

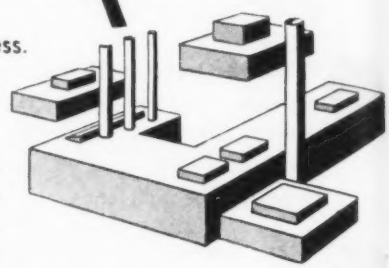


WESTON All-Metal Temperature Gauges are available in sizes and types for most industrial needs . . . as well as in laboratory models with full scale accuracy within ½ of 1%.

WESTON *All Metal* TEMPERATURE GAUGES

the degree

to which your communications problems are solved may determine the degree of your postwar business success.



The First of a New Series of Bulletins Introducing FREQUENCY CONTROL UNITS . . . Now Ready. Also an Attractive Binder to Hold Bulletins . . On Request

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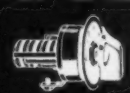
Cole-Hersee for your

Switches -

Toggle Type — Push Pull — Rotary



Sockets -

With wire leads or terminals for bayonet and flange type bulbs. Weatherproof — Vaporproof — Insulated

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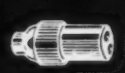
Multiple contact to fit bayonet sockets and companion plugs



Connectors -

Junction blocks — terminals — line, etc.

The *best* in switches, sockets, plugs and connectors can be developed to fulfill your current product design needs.
Our engineers are in the position to give you practical solutions to your problems.
Apply for Catalogue

Cole-Hersee Co.

QUALITY ELECTRICAL AUTOMOTIVE EQUIPMENT

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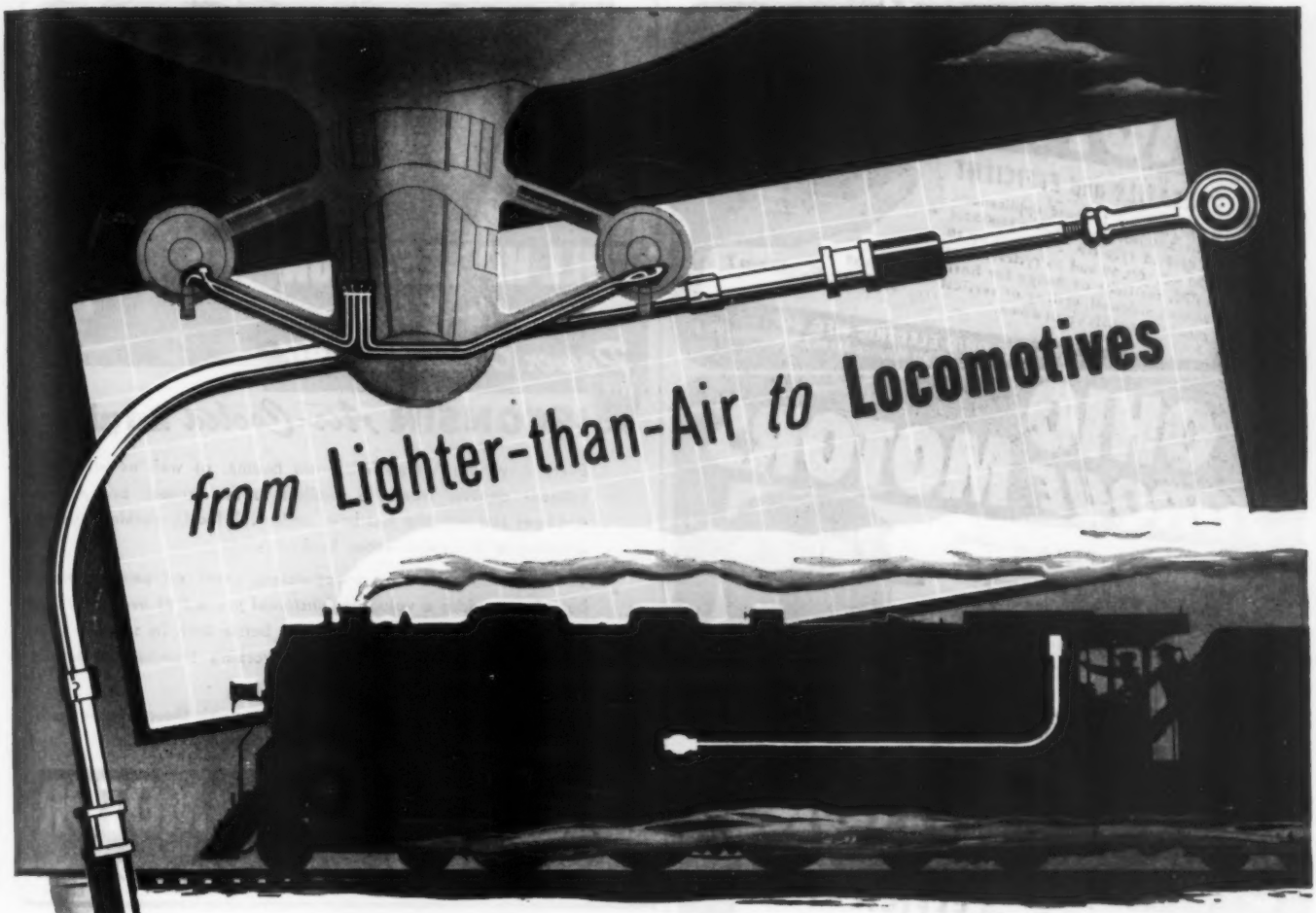

Simmonds Controls *provide a Soundly Engineered Solution to Every Push-Pull Problem*

LET SIMMONDS ANALYZE YOUR CONTROL PROBLEM

Simply submit the basic requirements, as follows:

- **What does the control operate?**
- **LOAD: Compression (lbs.) Tension (lbs.)**
- **VIBRATION CHARACTERISTICS**
- **TEMPERATURE CONDITIONS**
- **PRESENT SYSTEM**
- **FLEXIBLE OR RIGID HOUSING?**

Make sketches of top and side views of installation. Use regular graph paper and indicate unit of measure.

SIMMONDS EQUIPMENT FLIES WITH EVERY TYPE OF ALLIED AIRCRAFT

Automatic Engine Controls — Push-Pull Controls
Spark Plugs — Hydraulic Accumulators
Hydraulic Fuses — Chronometric Radiosondes
Fasteners and Clips of Specialized Design

WHETHER your remote control problem involves the coordination of a blimp's engine controls...the measuring of a locomotive's operating efficiency...or the limitless other examples in the wide range bracketed by these extremes — a ready solution is offered by the use of precision-built Simmonds-Corsey Push-Pull Controls.

Developed originally for aircraft uses, where dependability and efficiency are at a high premium, and proved in more than half a million installations, Simmonds controls offer to design engineers a simple but advanced system in the field of mechanical remote control, replacing the antiquated pulley and cable and rod and bellcrank arrangements. For a complete engineering analysis of your push-pull problems, send data concerning your requirements, as suggested in the panel at left, to the nearest Simmonds office today.

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OHIO Small MOTORS

VERSATILE and EFFICIENT

● For general purpose applications. Split capacitor type..1400 to 3400 RPM .. 1/80 to 1/20 HP . Voltages up to 220 AC..60, 50 and 25 cycles..bases solid, resilient or flange for horizontal, sidewall, ceiling or vertical mountings, shaft up or down.

What is Your Problem?

THE OHIO ELECTRIC MFG. CO.
5911 Maurice Avenue, Cleveland, Ohio

OHIO TORQUE MOTORS

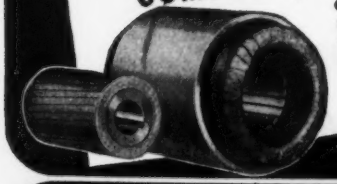
● Will rotate slowly or stand stalled exerting full torque without overheating for any time cycle. Ball bearing and quiet operating. Built for multiple or single phase a.c., and for direct current. Sizes to exert torque from 1 oz. ft. to 100 oz. ft. equal to 1/16 ft. lb. to 6¼ ft. lb.

WHAT IS YOUR PROBLEM?

THE OHIO ELECTRIC MFG. CO.
5911 Maurice Avenue, Cleveland, Ohio

OHIO Shell-type MOTORS

COMPACT and EFFICIENT



● Stator is pressed into a heavy steel shell and rotor is bored to be mounted on spindle. Stator and rotor are machined to very close limits. Ratings from ¼ to 5 HP—1150,1750 and 3500 RPM, 110, 220, 440 & 550 V. polyphase.

THE OHIO ELECTRIC MFG. CO.
5911 Maurice Avenue, Cleveland, Ohio

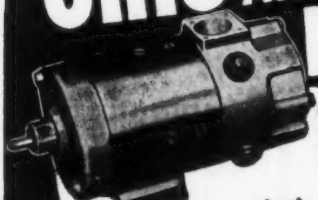
OHIO INTEGRAL MOTORS

● Fully enclosed. Rotor dynamically balanced. Runs quietly with minimum vibration. 2 or 3 phase, 60 or 50 cycles; voltages, 110, 220, 440 and 550; sizes ½ to 2 HP. Speeds from 860 to 3500 RPM. Odd voltages and cycles also available.

WHAT IS YOUR PROBLEM?

THE OHIO ELECTRIC MFG. CO.
5911 Maurice Avenue, Cleveland, Ohio

OHIO AIRCRAFT MOTORS



Furnished with or without magnetic brake and with or without cooling fan.

● Can be supplied as follows: Speeds up to 7500 RPM. Voltages 12 or 24 volts, DC. HP range 1/100 to ½ HP. Weight and length vary with HP and speed. Mounting and shaft to specifications.

THE OHIO ELECTRIC MFG. CO.
5911 Maurice Avenue, Cleveland, Ohio

FULL HP TEST RUN

Double-Checks Power Output of All

WISCONSIN Air-Cooled Engines

Every 4-cylinder V-type Wisconsin Engine, as well as all single cylinder engines from the smallest to the largest, are put on a 4-hour test run (the last hour under full load), working against a specially designed water brake.

This not only serves as an operating check on power output, but also provides a valuable *functional pre-test* of every working part . . . because no engine is any better than its smallest individual part, nor all of the parts working together in perfect mechanical coordination.

All this is important in relation to the work these engines may be called upon to do when *powering your equipment.*

Most H.P. per pound

WISCONSIN MOTOR Corporation

MILWAUKEE 14, WISCONSIN, U. S. A.

World's Largest Builders of Heavy-Duty Air-Cooled Engines

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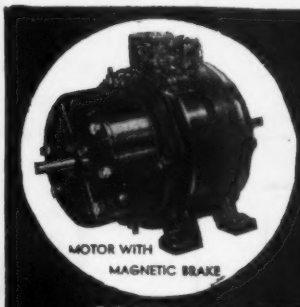


MOTOR WITH MAGNETIC BRAKE

ESCO

INDUSTRIAL
MARINE
AIRCRAFT
ELECTRONICS

A complete line of a.c., d.c., and Universal motors, d.c. and all Freq. a.c. generators; motor-generator converters, dynamotors, gas & Diesel Elec. plants; explosion proof units; Machines designed for every purpose.

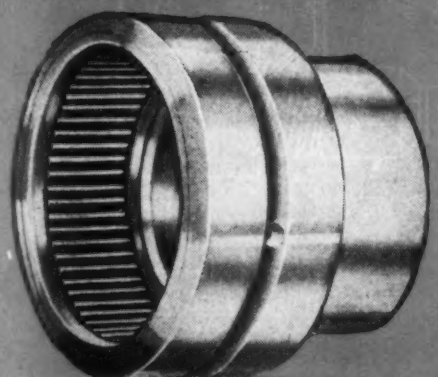
COMPLETE ENGINEERING SERVICE

Our engineers will be pleased to discuss your problems and aid in the design of machines to meet your requirements.

ELECTRIC SPECIALTY CO.

208 SOUTH ST. STAMFORD, CONN.

ORANGE
ROLLER BUSHINGS



In the Northrup Black Widow P-61 night fighter—world's largest, most powerful pursuit plane—Orange Roller Bushings take the load in the Nose Landing Gear Drag Brace, which reinforces the hydraulic shock struts.

High Load-carrying capacity in small space

Aircraft designers, who pinch every inch and count every ounce, have brought the science of weight and space saving to its highest development. The use of Orange Roller Bushings in special aircraft equipment and landing gear, verifies the high load carrying capacity in small space which these bearings have exhibited on all types of equipment.

Combining ruggedness with precision, Orange Roller Bushings stand up under severe service. Roller clearances are held to a minimum, thus all internal running clearances are closer, maintaining true alignment of rollers with the highly finished raceways.

Give your equipment the smooth, compact, anti-friction protection of Orange Roller Bushings. Available in a full range of sizes and types for most requirements. Send for Engineering Data Book showing design, sizes, capacities, installation data, etc.

Mail Coupon for Engineering Data

Orange Roller Bearing Co., Inc., Orange, N. J. 551

Please send me your Roller Bushing Data Book

Name ..... Title .....

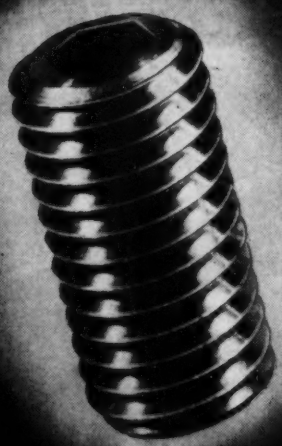
Company .....

Address .....

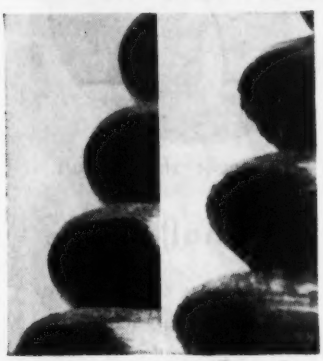
City ..... State .....

ORANGE ROLLER BEARING CO., INC.
551 Main Street, Orange, N. J.

PARKER-KALON *Presents* Ground Thread



Unretouched photograph of Ground Threads



SMOOTH, CLEAN THREADS Compare the superb finish of ground threads (left), with the tool-marred surfaces of cut threads (right). Ground threads reduce friction, speed assembly.

GUARANTEED CLASS 3 FIT Thread grinding by the new method makes sure of remarkable uniformity, assures fastenings of dependable security.

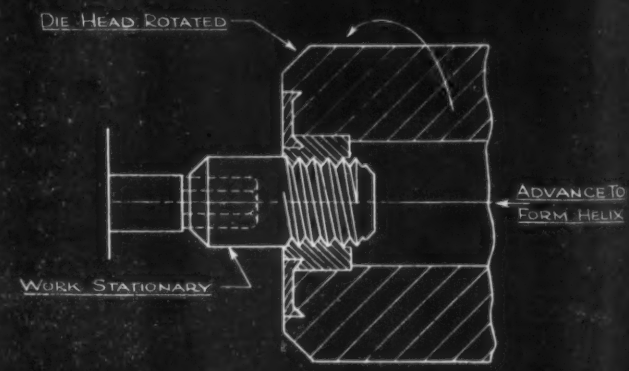
PERFECT THREAD CONTOUR AND LEAD The smooth surfaces and the accuracy of ground threads is immediately apparent in the comparator.

PERFECT STARTING THREAD The reason why P-K Ground Thread Set Screws start easier, and speed assemblies, may be easily seen in this closeup.

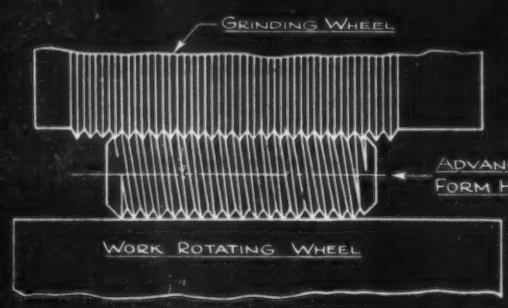
A Joint Achievement of LANDIS TOOL COMPANY and PARKER-KALON CORP.

The threads of the new Ground Thread Socket Set Screws are generated by the revolutionary new Landis Tool method of centerless thread grinding. These diagrams show the difference between the conventional method of cutting threads and the new Landis Tool method of ground thread grinding.

PARKER-KALON engineers have had the opportunity to cooperate with the Landis Tool Company in the adaptation of this revolutionary new Landis Tool method to the production of screws and to be the first to pioneer this process of ultra-precision manufacturing.



CONVENTIONAL THREAD CUTTING



CENTERLESS THREAD GRINDING

A revolutionary new process brings you socket set screws years ahead in quality . . . at no higher price!

SET SCREWS of GAUGE-LIKE ACCURACY

UP TO NOW, thread grinding has been a process employed only for finishing screws used in the finest precision equipment. It remained for Parker-Kalon – cooperating with the Landis Tool Company – to adapt thread grinding to quantity production of socket set screws . . . the most important development since the advent of this type of screw.

P-K GROUND THREAD SET SCREWS are *years ahead* in appearance, precision, and performance. The smooth, clean, gleaming finish has none of the nicks, burrs, or tool marks common to ordinary set screws. By every dimension test, they excel any previous standard for accuracy.

ASSEMBLIES ARE MADE FASTER with these superior screws, because they are held to standards of accuracy heretofore unattainable on a production basis.

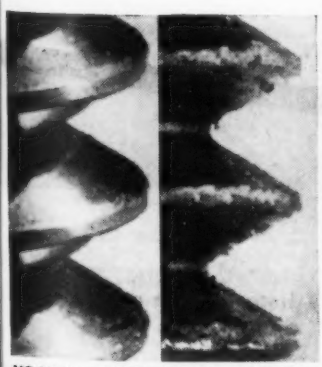
FREE SAMPLES will be sent at your request. Write now. Examine these finer Set Screws . . . you'll find it hard to believe *they cost no more!* Parker-Kalon Corporation, 196 Varick Street, New York 14, N. Y.

WHEN YOU CAN OBTAIN THESE NEW GROUND THREAD SET SCREWS . . .

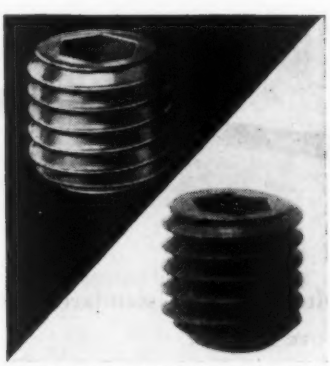
Present facilities are too limited to permit the building of adequate stocks. Therefore, orders cannot be filled at this time. As soon as additional equipment is put into production we will be in a position to take care of demands through our distributors. Meanwhile, free samples are available.

* * *

A PRODUCT OF PARKER-KALON SPECIALISTS IN FASTENING DEVICES



NO NICKS, NO BURRS, NO HARDENING CRACKS Threads are ground on a *hardened blank*, increasing thread strength, and preventing the imperfections common to cut threads.



DIFFERENT AS NIGHT AND DAY The years-ahead quality of the P-K Ground Thread Set Screw is apparent at a glance . . . proves out in performance.

PARKER-KALON
Ground Thread
SOCKET SET SCREWS

If you want a bolt or screw...

ALL OF THESE PRODUCTS ARE STANDARD

Cap Screws
Carriage Bolts
Carriage Bolts—Ribbed Neck
Clips—Wire Rope
Cotters
Dardelet Rivet Bolts
Elevator Bolts
Heel Bolts
Hub and Wheel Bolts
Lag and Skein Bolts
Lockwashers
Lockwasher Screws
Machine Bolts
Machine Screws
Nuts—HP, CP, SF, Castle, Machine Screw, Lock or Slotted
Pipe Plugs
Plow and Guard Bolts
Rivets
Self-Tapping and Sheet Metal Screws
Set Screws
Sink Bolts
Skein Bolts
Spring Center Bolts
Spring Clip Bolts
Step Bolts
Stove Bolts
Stove or Chair Rods—Headed and Threaded
Studs
Tire Bolts
Weather-Tight Bolts

• Ask the draftsman, or design engineer, in a plant using bolts in assemblies, to name a few "standard" bolts and he may begin by naming "cap screws, lag screws, carriage bolts, machine bolts, and . . ."—then he is likely to stop to consider. Chances are, he has named all those with which he is familiar.

But there are a great many more, as the long list of quite common "standard" bolts listed in the panel above reveals.

For instance, only a farm implement manufacturer would know that there are several types of "plow bolts"—standard bolts with implement manufacturers for generations. Some of these bolts are surprisingly like other bolts not used by implement

THAT MEETS ALL REQUIREMENTS AND IS EASY TO GET . . . . USE A "STANDARD" INSTEAD OF A "SPECIAL"

manufacturers, but by slight modification in dimensions and physicals serve other purposes.

Virtually all the bolts and screws used in the gigantic aircraft industry are almost exact replicas of existing bolts and screws used by other industries —excepting for materials of which they are made, more exacting fit and finish.

Frequently a customer designs a "special" bolt or fastening, assuming he cannot get or use a standard bolt. These "specials" require special dies, made of scarce die steels by even scarcer die-makers. Often critical materials are specified when less critical materials properly heat treated, would develop the required physicals. And all "specials" require special routing, handling and inspections throughout every step of their production.

Therefore we say, FIRST—find out from us if there is a standard bolt that may fit into your design. If there is not, perhaps you can re-design for a standard bolt *now,* saving time *later.* SECOND—determine if physicals can be met by less critical materials, heat treated to develop full strength. Lamson & Sessions maintains modern heat treating departments with chemical, physical and metallurgical laboratories manned by competent engineers. THIRD—if you cannot use a standard bolt, then call in a Lamson representative to discuss your problem. Out of his broad experience, he will probably be able to help you. And if you must have a "special" bolt tailored to your requirements, *we can make it on our bolt-making machinery faster than any other way.*

THE LAMSON & SESSIONS COMPANY, General Offices, Cleveland, O.
Plants at Cleveland and Kent, Ohio; Chicago and Birmingham

"BOLTS, NUTS & SCREWS"—1944 REVISION. Cloth bound. Limited edition, 180 pages of technical, practical information. Sent prepaid for *$1.00—cash or check must accompany your order.*

"BOLTS ARE IMPORTANT!"—24-page booklet of currently useful information for buyers of headed and threaded products, and describing Lamson & Sessions' specialty fastenings which have wide industrial applications *—now, and in the post-war period. Sent gratis.*

"THE LAMSON BLUE BOOK"—is our standard Catalog of standard products excepting our Aircraft products. *Sent gratis.*

"SIMPLIFIED STOCK LIST"—Of bolts, nuts and screws, conforming to latest revisions of the Office of Price Administration, and of great value in showing you in what ratio quantities of various standard products are kept in stock for deliveries, by your jobbers and in our own (and other bolt manufacturers') warehouse stocks. *Sent gratis.*

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Please send us ☐ Lamson Blue Book ☐ Bolts, Nuts & Screws **($1.00)**
☐ Bolts are Important! ☐ Simplified Stock Sizes

Send information on ☐ Cap Screws and Set Screws ☐ Cotters
☐ Bolts ☐ Machine Screws ☐ Lamson Lock Nuts
☐ CP, HP, SF Nuts ☐ Lock-washer Screws ☐ Self-Tapping Screws

Name of Individual — Title or Kind of Work

Employed by (Name of Company)

Street Address

City and State

No. 1897—Copyright 1945—The Lamson & Sessions Co.

LAMSON & SESSIONS

BOLTS · · NUTS · · COTTERS · · CAP SCREWS · · SPECIALS

Your Jobber Stocks the Lamson Line

100 YEARS *Making strong the things that make America strong*

COLD-FORGING Gives Them . . .

Top Strength, Accuracy, Appearance . . . Lowest Cost

These are the reasons why manufacturers needing metal parts like those shown above choose to have them produced by RB&W's cold-forging method . . .

Their *strength* is maximum, because cold-forging intensifies the grain and forms unbroken flow lines in the metal — at the same time automatically inspecting for serious imperfections which cannot escape being revealed by the severity of this operation.

Their *dimensions* are extremely accurate and their *finish* has a fine "quality" appearance, due to the close tolerances within which RB&W's modern cold-forging equipment holds the work.

And the *cost* of producing them is minimum; first, because the RB&W machinery operates at very high speeds and, second, because in cold-forging the scrap waste is virtually eliminated.

THE LONGEST EXPERIENCE IN AUTOMATIC COLD-FORGING

This is RB&W's 100th year. The history of this company is also the history of automatic cold-forging, for it introduced the original automatic cold-heading machine and has since pioneered in many respects to improve the quality and lower the costs of fasteners and other parts which can be cold-forged.

In planning new parts, consider the many metal shapes which can be produced by cold-forging and also that RB&W's experience and facilities make it your logical source of supply. At present wartime commitments have monopolized those facilities; meanwhile, keep in mind the advantages of this method.

RB&W

Russell, Burdsall & Ward Bolt and Nut Company. *Factories at:* Port Chester, N. Y., Coraopolis, Pa., Rock Falls, Ill. *Sales offices at:* Philadelphia, Detroit, Chicago, Chattanooga, Los Angeles, Portland, Seattle . . . with the industry's most complete, easiest-to-use catalog.

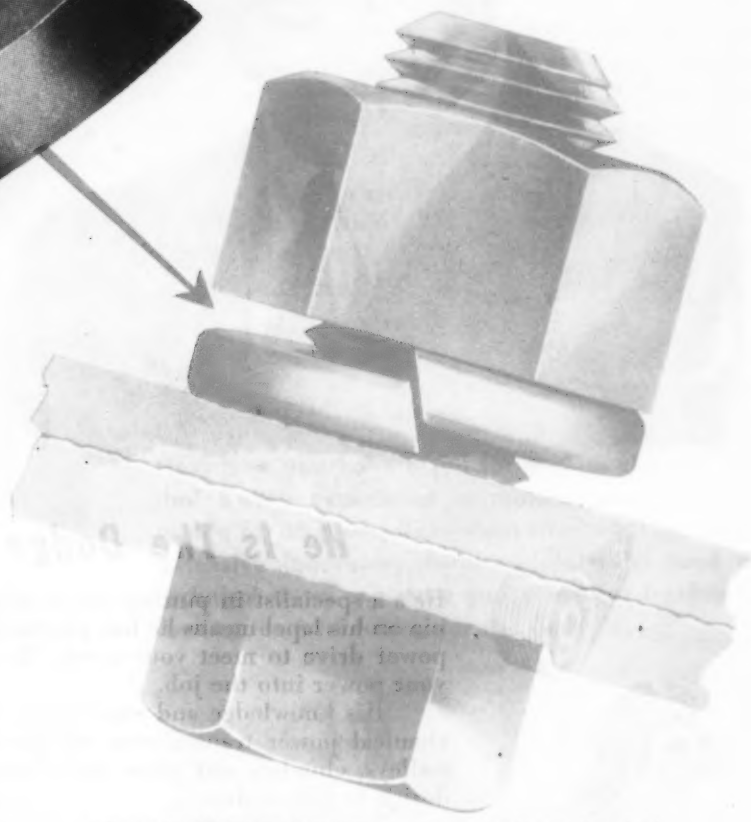
BOLTS EMPIRE RIVETS

AND ALLIED FASTENING PRODUCTS · SINCE 1845

RUSSELL, BURDSALL & WARD BOLT AND NUT COMPANY

The Spring OF LIFE

FOR ALL BOLTED ASSEMBLIES



Wherever metal touches metal there is inevitable wear. Vibration loosens all bolted assemblies. That's why you must use a powerful wide-range spring washer to retard initial wear, and then to expand and hold tight all parts of your assemblies.

The nut never budges on the bolt when there is the slightest pressure on the threads; it's the other parts that need the spring of life. Kantlinks are springs of life to all bolted assemblies.—There is no substitute for a long-range spring washer.

Let us send you samples—send details of your application. Test and compare them on the same job with any type of nut, or with any other type of washer.

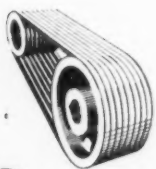
Our Kantlink Spring Washers conform to Ordnance Standard Specification BECX 1-2-3-, and Army-Navy Aeronautical Standard AN 935, and U. S. Navy drawing 12-Z-22.

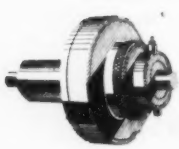
Originators of KANTLINK TRADE MARK the long-range spring washer

NATIONAL LOCK WASHER COMPANY

NEWARK, NEW JERSEY, U. S. A.

HE KNOWS WHAT'S RIGHT IN POWER DRIVES





He Is The Dodge Transmissioneer

He's a specialist in putting power to work, graduate of a factory course. That insignia on his lapel means he has proved his qualifications to prescribe the most efficient power drive to meet your needs. He can show you new and better ways to put *all* your power into the job.

His knowledge and experience are backed by America's broadest line of mechanical power transmission equipment — Dodge precision-built bearings, sheaves, pulleys, clutches and other drive components. Transmissioneered means advanced design in power drives.

Transmissioneering service is nation-wide — there are 210 Dodge factory graduate Transmissioneers in principal cities. Whenever you have a problem in power application, call a Transmissioneer — your local Dodge distributor. He has the latest answer. Often your immediate needs can be supplied from local stock.

DODGE MANUFACTURING CORPORATION, MISHAWAKA, INDIANA, U. S. A.

DODGE
MISHAWAKA

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THE RIGHT DRIVE FOR THE JOB

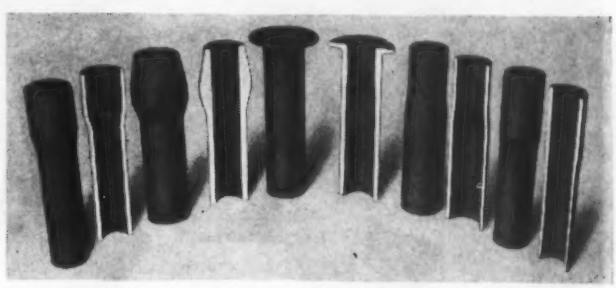
All Kinds of Steel Tubing for All Kinds of Jobs

B&W Mechanical Tubing is available in all carbon steels, NE alloys, SAE alloys, stainless and corrosion resistant steels.

Finding the right kind of tubing—Seamless or Welded—for each mechanical requirement is greatly simplified when the problem is put up to Babcock & Wilcox. Matching tubes to jobs—finding the steel analysis best suited for each purpose—is a specialty with B&W.

To this end, metallurgists and technicians are continuously searching for better alloys—testing for proper hardness and hardenability—checking yield strengths, elongation, and tensile strengths against service demands. At B&W your problems are considered in the light of experience with an unusually large variety of analyses, many of them available from no other source; first hand knowledge of the fabricating, machining, heat-treating, and other capabilities of steels from simple low carbons to high alloys. Making a complete range of both Seamless and Welded Tubing, B&W is in a position to match tubes to jobs without prejudice toward any type of materials. B&W recommendations are therefore impartial and unbiased.

Next time you have a job for tubing, chances are that B&W's experience in making and applying tubing for 35 years, its modern specialty tube mills, extensive laboratory facilities and vast fund of technical data, can save you time and trouble in finding the best tubing for the purpose.



Typical examples of special forms of B&W Mechanical Tubing

B&W MAKES BOTH

B&W TUBES

SEAMLESS. Complete range of carbon, alloy and Stainless steels. Sizes ½ in. to 8⅝ in. O.D.
ELECTRIC-RESISTANCE WELDED Carbon steel grades. Sizes: ¾ in. to 4 in. O.D.

THE BABCOCK & WILCOX TUBE CO.

Welded Tube Division, Alliance, Ohio
Seamless Tube Division, Beaver Falls, Pa.

TA-1329

6249

HOLO-KROME *fibro forged* SOCKET SCREWS

. . . YOU CAN SAVE WEIGHT, SPACE AND ASSEMBLY TIME

PRECISION MADE TO EXACTING STANDARDS

. . . USE THIS BETTER FASTENING METHOD

It's the Internal Wrenching feature! Save material (weight) due to the reduced area needed for fastening members . . . more compact design (space) . . . stepped-up production (assembly time) because of the quick and positive tightening . . . Adopt this better fastening method to your production—specify "HOLO-KROME".

GUARANTEED
UNFAILING PERFORMANCE

The **HOLO-KROME**
SCREW CORPORATION
Main Offices & Plant
HARTFORD 10, CONN., U. S. A.

The cornerstones are ours . . .

WE'RE old hands at basic engineering. From the time we were small fry, it's been our practice to conduct our own research—lay our own cornerstones. It's a practice that's bred unusual engineering talent, led to the development of uncommonly good equipment. This inherent sense of responsibility is one reason why **Aireon** hydraulic and electronic equipment is widely used by the armed forces and many of the country's major airlines. And reason enough why **Aireon** has shown a steady growth over its eight years of operation. **Aireon** executives grew up in the aviation field; appreciate its possibilities, understand its future requirements. Our engineers are particularly well equipped to design what you want from the ground up; our plants to translate your postwar plans into finished products. Glad to talk it over whenever you say.

Aireon

MANUFACTURING CORPORATION

Formerly *AIRCRAFT ACCESSORIES CORPORATION*

Radio and Electronics • Engineered Power Controls

NEW YORK • CHICAGO • KANSAS CITY • BURBANK

Quiet

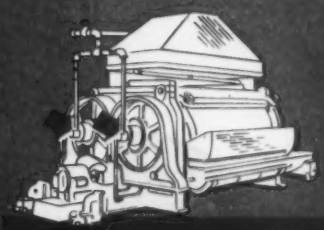
HOOVER

BALL AND BEARING COMPANY
ANN ARBOR, MICHIGAN

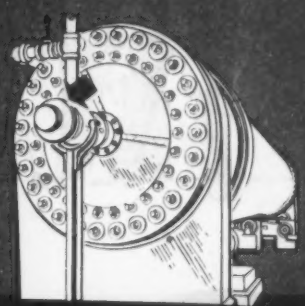
BALLS - BALL BEARINGS - ROLLER BEARINGS

MORGANITE SEAL WASHERS

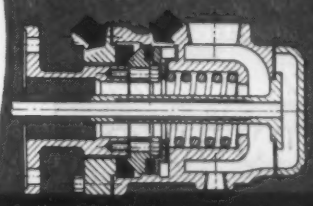
...longevity prescription for equipment and machines running high temperatures!



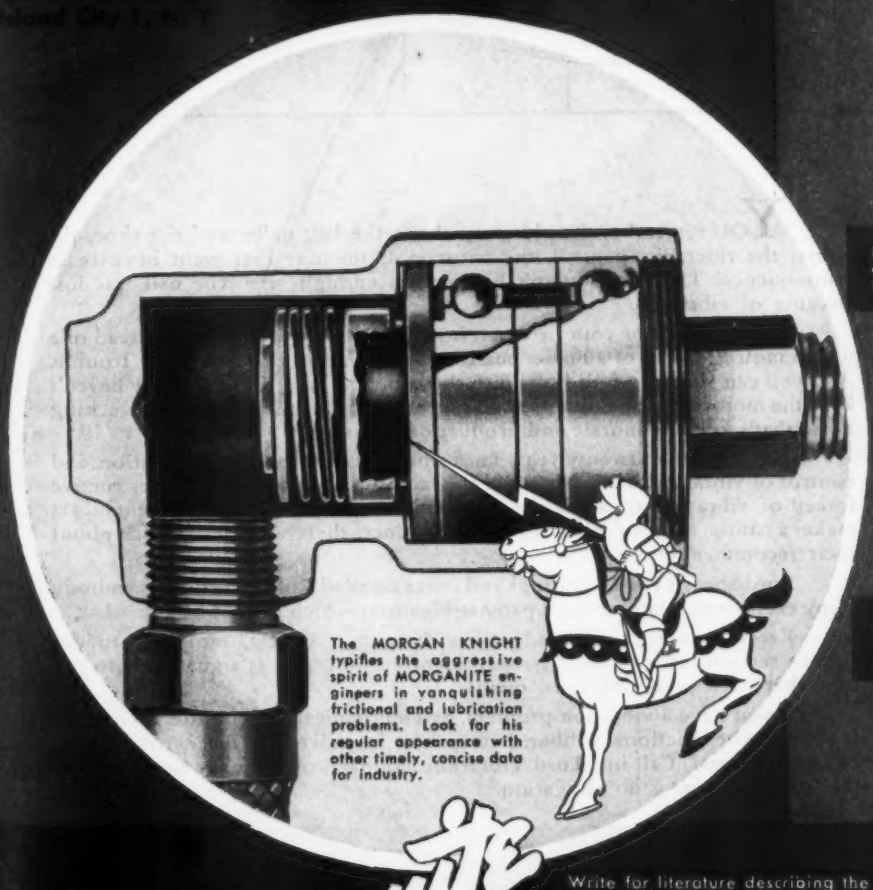
Replaceable seal unit illustrated in circle is especially suited to dryers of this type.



Large equipment with built-in seal assembly, utilizing MORGANITE self-lubricating ring.



Sectional view showing details of above seal ring application, and emphasizing the necessity for self-lubrication.



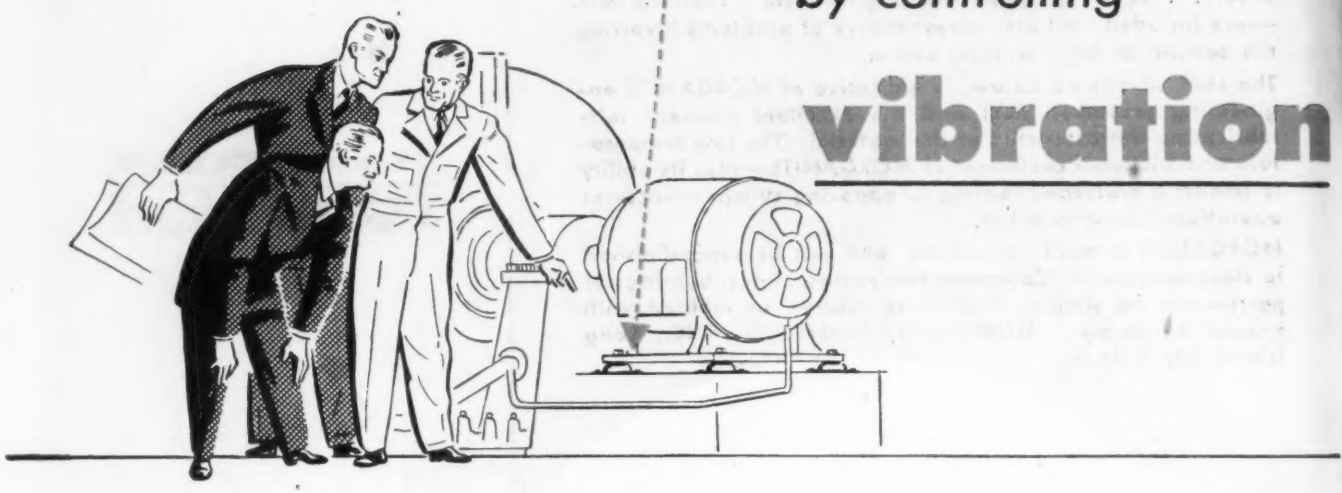
The MORGAN KNIGHT typifies the aggressive spirit of MORGANITE engineers in vanquishing frictional and lubrication problems. Look for his regular appearance with other timely, concise data for industry.

Write for literature describing the complete line of MORGANITE products, including motor and generator brushes. Brochures will be sent promptly on request without obligation, together with details concerning MORGANITE engineer-designer collaboration.

Morganite

CARBON SPECIALTIES

Protection starts here by controlling vibration



LORD
SHEAR TYPE
Bonded Rubber
MOUNTINGS

YOU remember the old story about the lost nail—and the shoe, the horse, the rider, the general, the battle, and the war that went haywire in consequence. The story doesn't begin soon enough — the nail was lost because of vibration.

In your plant or your product, it may be a screw . . . a bolt instead of a nail; a motor instead of a horse; but it's still vibration that starts the trouble. And you can sink two-foot bolts into the concrete base, but still you haven't kept the motor from shaking itself to pieces, or diminished the nerve wracking noise that's keeping morale and production down.

For more than twenty years Lord's business has been the isolation and control of vibration. Lord has lifted the methods of attack on the destructive forces of vibration to a highly developed science. When Lord engineers make a study of your plant or your product, there's no guesswork about their recommendations.

Lord Shear Type Mountings and other Bonded Rubber Products embody many exclusive techniques and patented features which cannot be copied.

Every genuine Lord Product has the name "LORD" molded into the rubber section, as a means of ready identification, and as a guarantee to the user that he is receiving Lord quality.

If you have a vibration problem, or a mechanical design problem involving the use of functional rubber, it may best be solved by means of rubber-bonded-to-metal. Call in a Lord Vibration Engineer, or write for literature on the subject. There is no obligation.

IT TAKES **BONDED RUBBER** *In Shear* **TO ABSORB VIBRATION**

LORD MANUFACTURING COMPANY
ERIE, PENNSYLVANIA

SALES REPRESENTATIVES
NEW YORK 280 MADISON AVE
CHICAGO 520 N. MICHIGAN AVE
DETROIT 7310 WOODWARD AVE
BURBANK, CAL. 245 E. OLIVE AVE
CANADIAN REPRESENTATIVES
RAILWAY & POWER ENGINEERING CORP. LTD.
TORONTO, CANADA

BUY MORE WAR BONDS

Originators of Shear Type Bonded Rubber Mountings

DESIGN / PRODUCTION / MAINTENANCE

Pictured above is a group of engineered assemblies of American Flexible Metal Hose, each completed with a type of fitting or coupling to suit a specific application.

Such assemblies become an integral part of a machine or product design and serve in most exacting production and maintenance duties such as for carrying liquids, oils, grease, hot and cold water, steam, semi-solids; for absorbing vibration in feed or exhaust lines, and compensating for misalignment of tappings.

For all-around conveying duties between moving parts, such as the platens of molding presses, laundry presses; supplying steam to automobile tire molds; carrying delicate essential oils from tank to filters; serving as hydraulic oil lines on giant steel strip mills . . . and thousands of other industrial services. . . . American has a style of Flexible Metal Hose specially constructed to do the job.

American Metal Hose Assemblies withstand constant flexing for almost unbelievable periods . . . can be built to take very high pressure. For instance American "Seamless" . . . the flexible tubing with no joints, welds, seams or packing is as leakproof as the seamless rigid tube from which it is made . . . its cost per foot per hour of service is amazingly low.

American Flexible Metal Hose and Tubing has contributed mightily to war work . . . will again find even more widespread use in civilian production than it has in the last 35 years. Ask for available literature . . . get the facts on what it can do for you.

ANACONDA
from mine to consumer

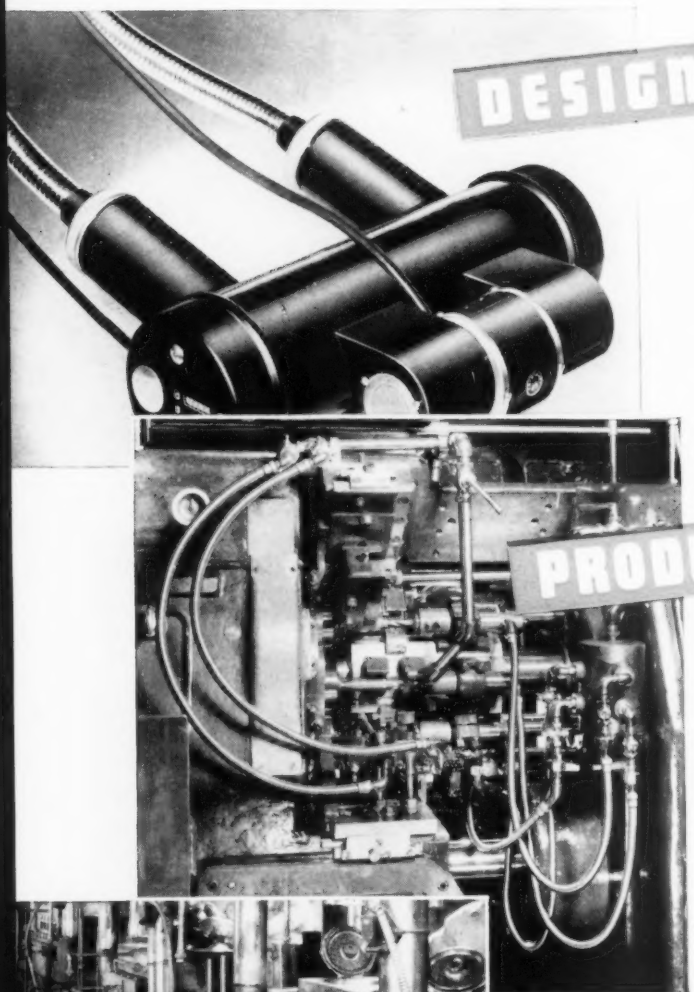
American Metal Hose

AMERICAN METAL HOSE BRANCH of THE AMERICAN BRASS COMPANY

General Offices: Waterbury, Conn. Subsidiary of Anaconda Copper Mining Company

In Canada: Anaconda American Brass Ltd., New Toronto, Ont.

FOR BETTER METHODS AND SMOOTHER PERFORMANCE IN *Design, Production* AND *Maintenance* — AMERICAN METAL HOSE

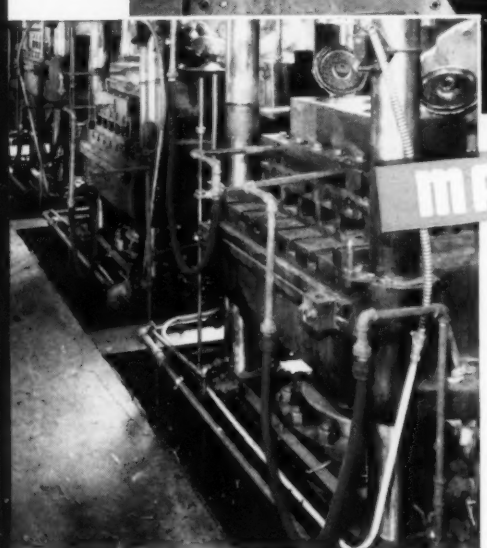


DESIGN....

Machine and Product Designers find many advantages in getting American Metal Hose on their drawing boards "*right* from the start". Appearance is enhanced, connecting and dis-connecting of pipe lines is facilitated, longer service life of machinery is assured. Note the use of "American" to protect cable on this X-ray machine.

PRODUCTION....

Oil feed lines, such as those shown on this multiple spindle automatic Bar machine, must stand up under severe conditions. That is exactly what you may expect and depend upon with all types of "American" Flexible Metal Hose and Tubing. It is equally true of steam, hot water and hydraulic pressure lines that are installed to flex with moving parts. Specify "American" for sure-fire performance, lower service costs, easier installation, and resistance to vibration.



MAINTENANCE....

Machine down-time is minimized when equipment, such as this battery of plastics presses, has flexible feed lines connected with re-attachable couplings, made the "American" way. The lines may be easily changed, or re-located to suit requirements. The maintenance duties of American Metal Hose include blowing of chips, vacuum cleaning of dust, dirt, etc., and insertions in exhaust lines to absorb vibration, expansion and contraction.

There are many places for American Flexible Metal Hose in practically every industrial plant both to improve products and decrease maintenance. Our Engineering Service will gladly make specific recommendations on request.

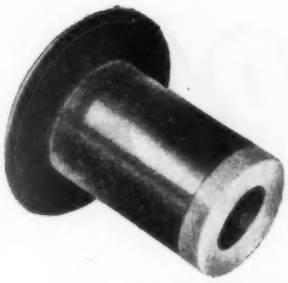
American Metal Hose Branch *of* The American Brass Company

General Offices: Waterbury, Conn. • *Subsidiary of Anaconda Copper Mining Company*

ANACONDA from mine to consumer

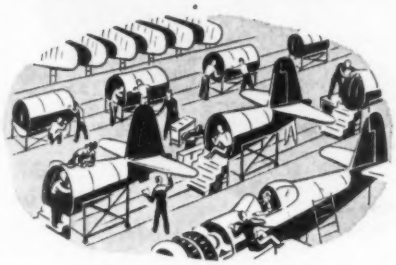
In Canada: Anaconda American Brass Ltd., New Toronto, Ont.

45255



Got a riveting job in a hard-to-get-at spot?

Widely used by aircraft manufacturers . . .



Du Pont Explosive Rivets aren't new. In the past three years many millions of them have been used in building Uncle Sam's powerful air fleet. They've helped speed construction . . . cut costs. They've solved the problem of riveting in awkward, hard-to-get-at places. And day-by-day new time and money-saving applications are being found for them.

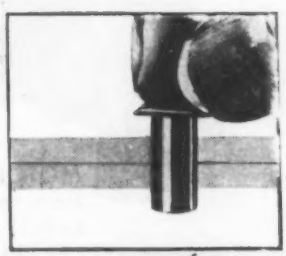
EXPLOSIVE RIVETS ARE EASILY INSTALLED

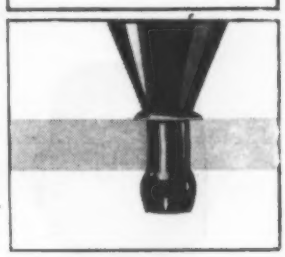
Just two simple steps:

1. Insert Explosive Rivet in the hole.

2. Apply tip of heated Du Pont Riveting Iron to Rivet head.

In 1½ to 2½ seconds the Rivet is set and a strong, tight joint is formed. No after operation is required to give the head of the Rivet a finished appearance. It's a one-man job from start to finish.





IF YOU HAVE A POST-WAR RIVETING JOB . . .

Whether you expect to fabricate bus or passenger car bodies, radio or refrigerator cabinets, air conditioning ducts, heating and ventilating equipment, household appliances or any riveted commodity . . . consider Explosive Rivets. They may help you do the job better, easier, quicker . . . and at lower cost.

DU PONT
REG. U.S. PAT. OFF.

Send for this useful Manual TODAY!

..... Contains complete information
..... shows typical applications
..... explains how to select and use these modern, one-piece blind fasteners.

E. I. du Pont de Nemours & Co. (Inc.)
Explosives Department
Wilmington, Delaware

Please send a copy of "High Speed Blind Riveting with Du Pont Explosive Rivets."

*Name*_____

*Company*_____

*Street*_____

*City*_____ *Zone*____ *State*_____

DU PONT EXPLOSIVE RIVETS

The only one-piece blind fastener

Established 1888

D.O.James

MOTORIZED

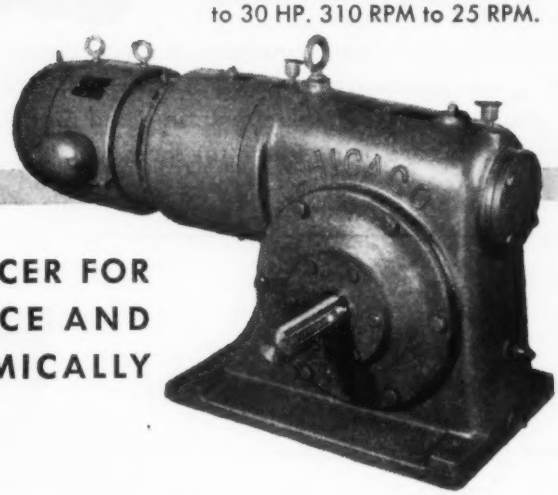
SPEED REDUCERS

MOTORIZED PLANETARY REDUCER
Horizontal drive. 35 sizes. Ratios 10 to 1200:1. ¾ to 75 HP. 172 RPM to 74 RPM.

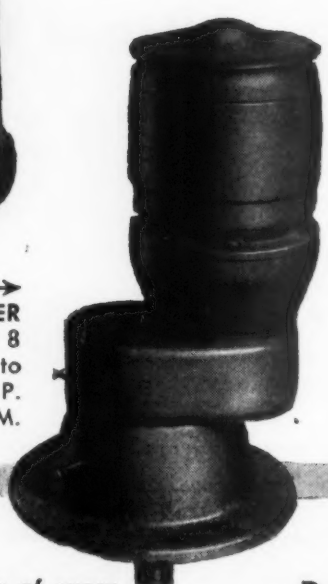
MOTORIZED HELICAL REDUCER
Horizontal drive. 8 sizes. Ratios 1¼ to 9:1. ¾ to 50 HP. 1458 RPM to 128 RPM.

MOTORIZED WORM GEAR REDUCER
Horizontal and vertical drive. 11 sizes. Ratios 6 to 65:1. ⅛ to 30 HP. 310 RPM to 25 RPM.

MOTORIZED PLANETARY REDUCER
Vertical drive. 35 sizes. Ratios 10 to 1200:1. ¾ to 75 H.P.
← 172 RPM to 74 RPM.



THE IDEAL GEAR REDUCER FOR LIMITED FLOOR SPACE AND IS OPERATED ECONOMICALLY



MOTORIZED → HELICAL REDUCER
Vertical drive. 8 sizes. Ratios 1¼ to 9:1. ¾ to 50 HP. 1458 to 128 RPM.

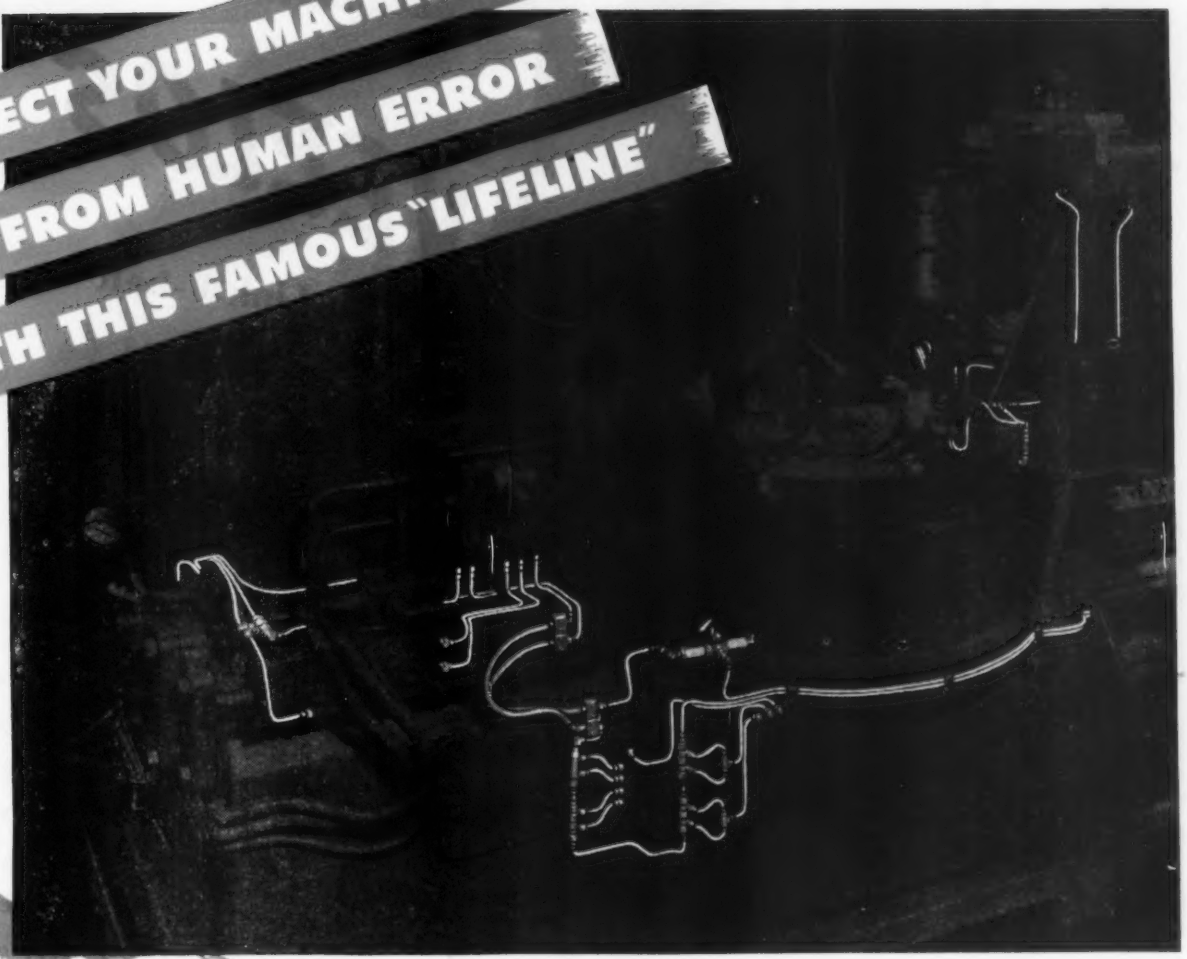
The design and manufacture of D.O.James motorized reducers embodies all the high quality of construction of our standard gear reducers. In addition to this in-built quality you have many advantages — such as compactness, lower cost and elimination of separate supports, thereby saving valuable floor space. D.O.James Motorized Reducers are manufactured to drive up, down, horizontally or at an angle.

D.O.James

Over 57 years makers of every type of gear and gear reducer.

D. O. JAMES MANUFACTURING CO.
1140 W. MONROE STREET, CHICAGO, ILL.

PROTECT YOUR MACHINES FROM HUMAN ERROR WITH THIS FAMOUS "LIFELINE"



That "Lifeline" is a system of metal arteries that feeds the life blood of oil or grease to every part of your machine. It's called Alemite Centralized Lubrication. An even better name is "fool-proof lubrication" because it eliminates the danger of costly human error.

It's "life insurance" for your machine because each bearing, no matter how inaccessible, is given a positive delivery of measured quantity of oil or grease. Machines need not stop for lubrication as the bearings are lubricated from a central point. These time-, and machine-saving advantages are the reasons why plant owners are installing Alemite Centralized Systems on present equipment. They're also excellent reasons why you should consider including Centralized Lubrication in the machines you're designing now.

The four new Alemite Centralized Systems are adaptable to almost any type machine for manual or automatic operation. Expect results like these: seven big punch presses totaling 86 bearings are now positively lubricated from *one* central point in *3 minutes, twice a week* while the presses are in operation. Former lubrication time—*20 minutes per press every other day* and the presses had to be stopped for lubrication.

Your machines get potent sales points when they're equipped with Centralized Lubrication. They're protected against human error in lubrication. Your machines last longer and have "M.P.T."* designed into them. You also eliminate costly field service. And, through improved performance, your machines keep building up your reputation as a designer.

*More Productive Time

Another Product of STEWART WARNER

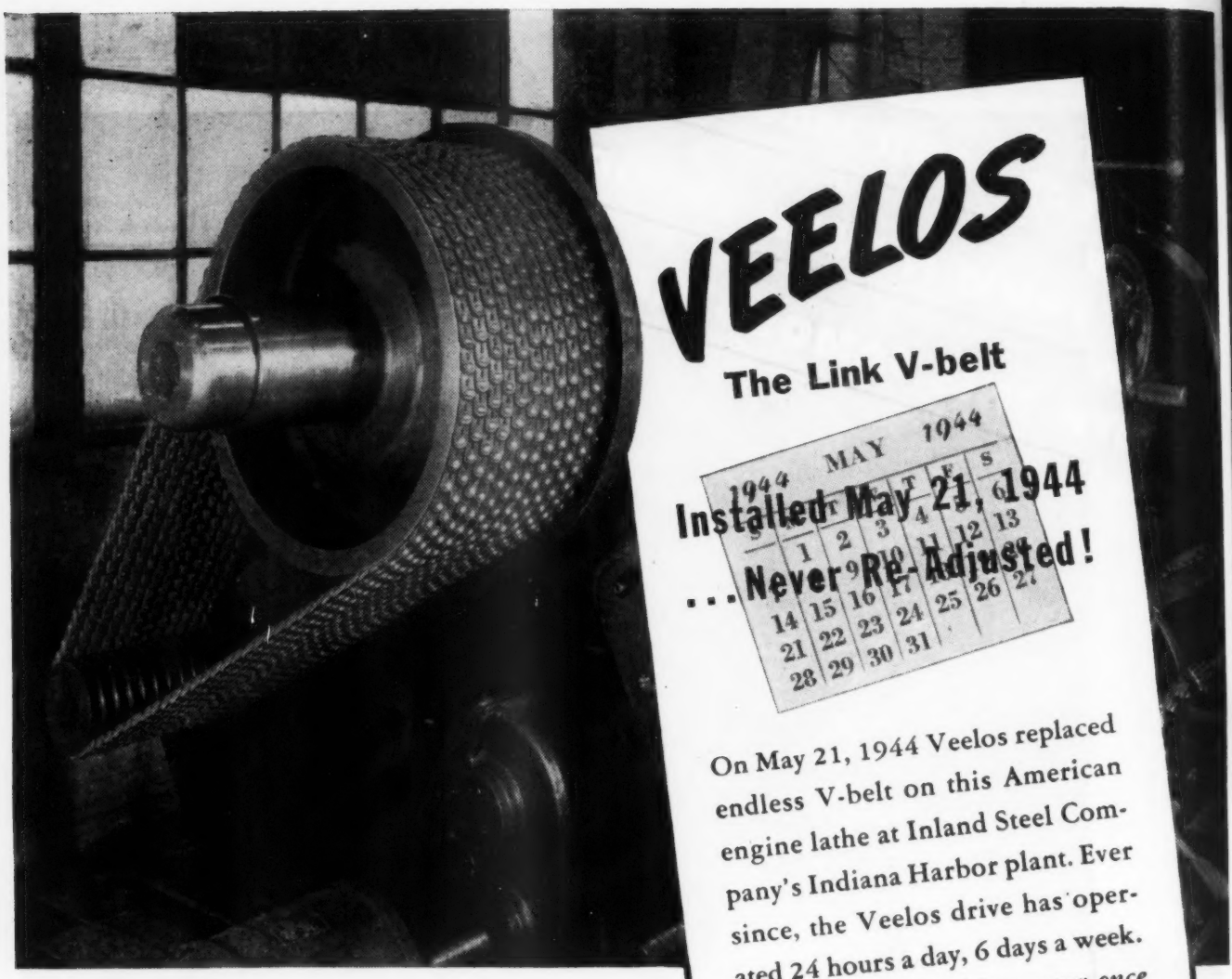
ALEMITE
REG. U.S. PAT. OFF.

First in Modern Lubrication

Ask for an "on the desk" Demonstration of the 4 New Alemite Systems

Without obligation, have an Alemite Lubrication Specialist call and demonstrate Centralized Lubrication with four transparent working models. You can study them at close range– actually work them yourself at your desk. If you like, the Alemite Specialist will gladly give you any technical help or information you may want regarding the adaptation of Alemite Centralized Systems to your machines. Drop a note on your letterhead to Alemite, 1808 Diversey Parkway, Chicago 14, Illinois.

CONSULTATION • ENGINEERING • EQUIPMENT • LUBRICANTS • MAINTENANCE



VEELOS

The Link V-belt

Installed May 21, 1944
...Never Re-Adjusted!

On May 21, 1944 Veelos replaced endless V-belt on this American engine lathe at Inland Steel Company's Indiana Harbor plant. Ever since, the Veelos drive has operated 24 hours a day, 6 days a week. *Yet the Veelos belt has never once been re-adjusted.* That's a remarkable record!

In Every Type of Industry...
as In the Steel Industry...
Link Construction Ups Production

Link construction of Veelos turned the trick at Inland... and link construction makes Veelos the most adaptable of V-belts for any drive. Quick, easy tension adjustment ends slippage ...keeps machinery running at full speed and productivity.

With Veelos, design engineers can *fit the belt to the drive—rather than the drive to the belt.* Write today for free Veelos manual giving complete details.

MANHEIM MANUFACTURING & BELTING CO.
MANHEIM, PENNSYLVANIA

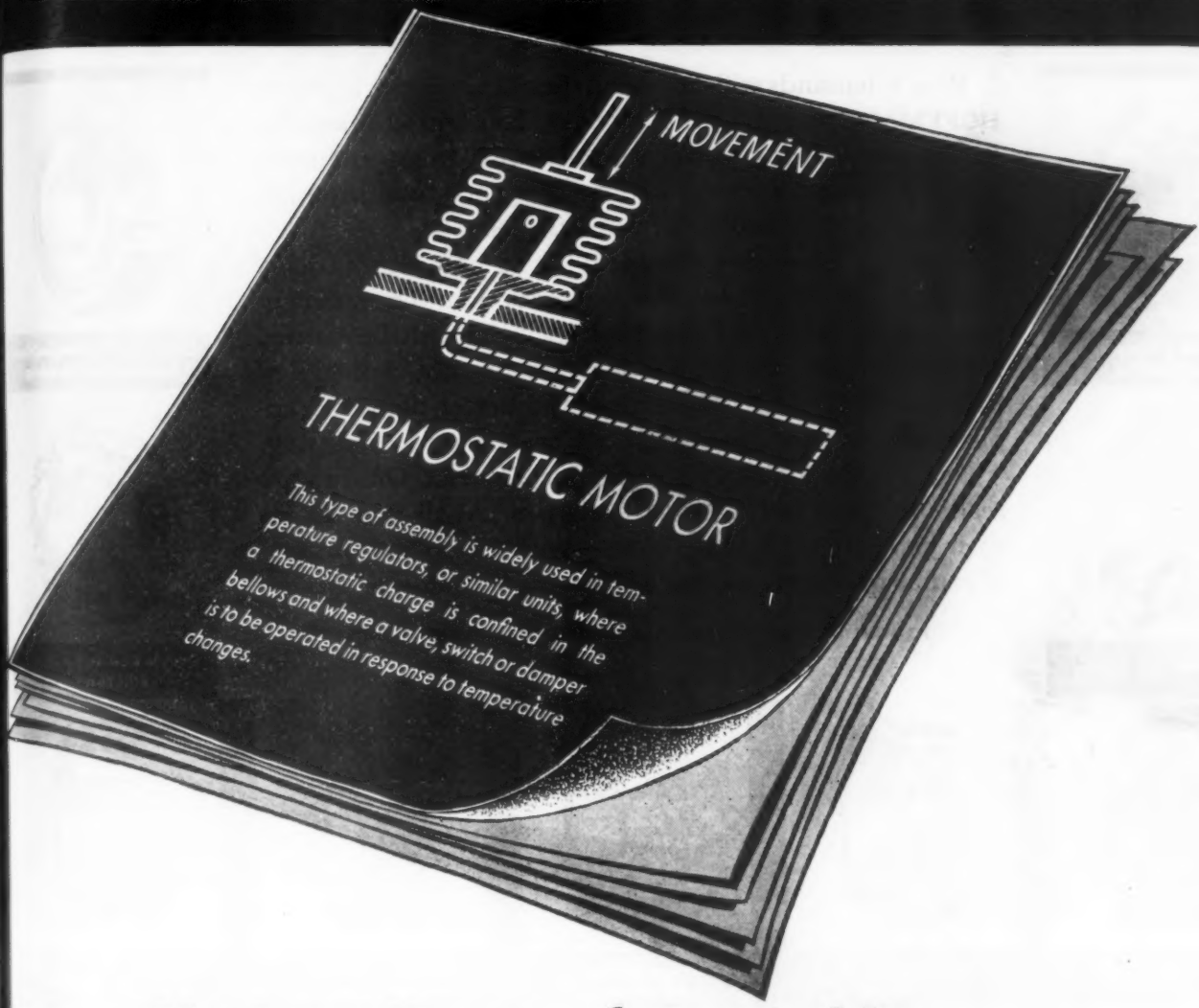
Simple as Buttoning a Shirt

Get the "hang" of it, and you'll couple and uncouple Veelos as easily as you button your shirt. This unique, link construction is the big reason why *production goes up when Veelos goes on.*

VEELOS
THE LINK
V-BELT

Adjustable to any Length
Adaptable to any Drive

FROM SIMPLE BASIC APPLICATIONS...


MOVEMENT
THERMOSTATIC MOTOR
This type of assembly is widely used in temperature regulators, or similar units, where a thermostatic charge is confined in the bellows and where a valve, switch or damper is to be operated in response to temperature changes.

Come Various Types of Assemblies

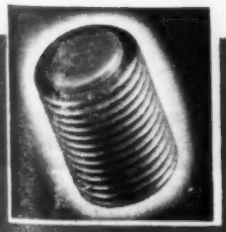
It would be difficult to think of a control device as simple as a bellows, or one as effective and efficient.

Temperatures and pressures are translated into direct motor action; expansion is absorbed; motion is transmitted; rotating shafts sealed, all by means of bellows and bellows assemblies. In fact, correctly designed and engineered bellows offer simple solutions to many seemingly complicated problems.

Bridgeport Bellows are unit-constructed, with no seams or solder. They are built to serve indefinitely.

Whatever your problem—if it conceivably concerns bellows, we would like to discuss it with you. Our engineering department is at your service; our manufacturing facilities, complete and ready to meet your schedules.

Write for new catalog GP-100.

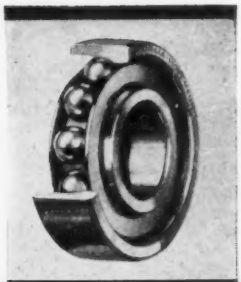


Bellows Assemblies . . . Bellows . . . Bellows Devices

BRIDGEPORT THERMOSTAT COMPANY, INCORPORATED

VICTORY, first: THEN-

PRECISION BEARINGS FOR EVERY PURPOSE, INDUSTRIAL AND DOMESTIC



Separable (Magneto) Ball Bearing

Single Row Ball Bearing

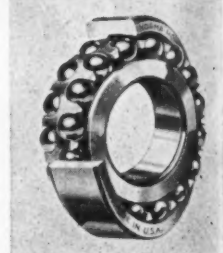
War's demands still call for all the output of the NORMA-HOFFMANN factory. But, already, far-sighted manufacturers are working with NORMA-HOFFMANN engineers on their designs for new and better peace-time products equipped with PRECISION BEARINGS.

No "Re-conversion Problem" will hamper or delay NORMA-HOFFMANN post-war production. The moment peace is declared, all our vast facilities will be turned INSTANTLY to the production and prompt delivery of PRECISION BEARINGS for new and better domestic appliances and for new and better tools for industry.

Our Field Engineers, in all our District Offices, are ready to work with YOUR designers. Avail yourself of their experienced counsel NOW—without obligation, and of course in strict confidence. *Write for the Catalog—Today.*

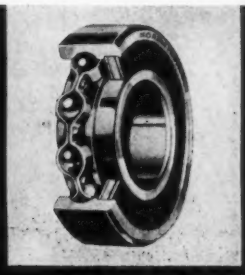
TO WIN THE WAR: WORK—FIGHT—BUY WAR SAVINGS BONDS!

Litro ("CL") Composition Retainer Ball Bearing

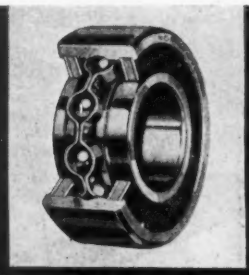


Double Row Self-Aligning Ball Bearing

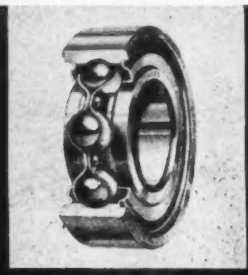
Shielded Type Single Row Ball Bearing



Single Felt Seal Ball Bearing

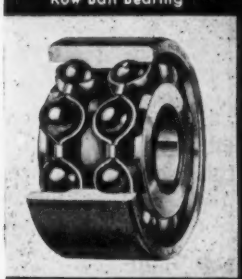


Double Felt Seal Ball Bearing

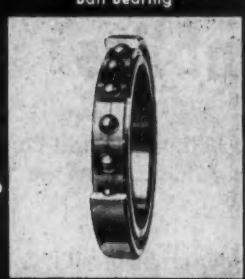


9000 Series (Feltless) Sealed Ball Bearing

"Cartridge" Fully Sealed, Refillable Type Ball Bearing



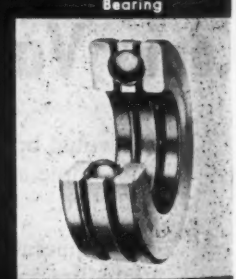
Double Row Ball Bearing



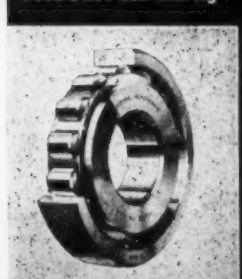
Extra Light Type Ball Bearing

Angular Contact Ball Bearing

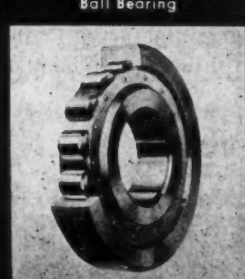
Extra Light Single Direction Ball Thrust Bearing



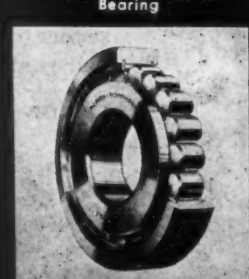
Single Direction Ball Thrust Bearing



Standard Cylindrical Roller Bearing

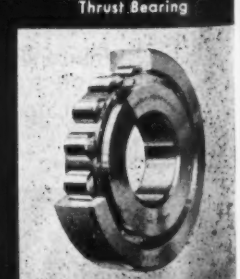


Type "E" Cylindrical Roller Bearing



Full Type (Retainerless) Cylindrical Roller Bearing

Extra Light Cylindrical Roller Bearing



Two-Lipped Cylindrical Roller Bearing

NORMA-HOFFMANN BEARINGS CORP'N. STAMFORD, CONN. *Founded* 1911

Field Offices: NEW YORK • CHICAGO • CLEVELAND • CINCINNATI • PITTSBURGH • DETROIT • LOS ANGELES • SAN FRANCISCO • SEATTLE, WASH.

The wire you need...

Wide Range of Types
Wire is supplied for magnet coils, aircraft and automotive electrical systems, ignition cable, radio wire and flexible cord and other assemblies.
Wide Range of Shapes and Sizes
Wire is drawn round, square or rectangular in all sizes. A complete selection of materials is offered.
Wide Range of Insulations
Insulations of all types are available including special developments like Auto-Lite's B-Braid Vinylite insulated Cable, whose resistance to abrasion has been of great advantage in aircraft building.

You can get Auto-Lite wire and cable in a full range of sizes, shapes and materials.

The conditions for wire and cable vary greatly. Auto-Lite can supply your needs and, when it is desirable, help you determine the wire or cable which will give you best results.

Insulations of all types are available including special developments like Auto-Lite's Vega Chromoxide Enamel, an insulation of decided advantage where resistance to heat is of paramount importance.

For further information on your specific problem, write to

THE ELECTRIC AUTO-LITE COMPANY
Wire and Cable Division
PORT HURON, MICH. SARNIA, ONT.

Back the Attack—Buy War Bonds

AUTO-LITE ELECTRICAL WIRE and CABLE

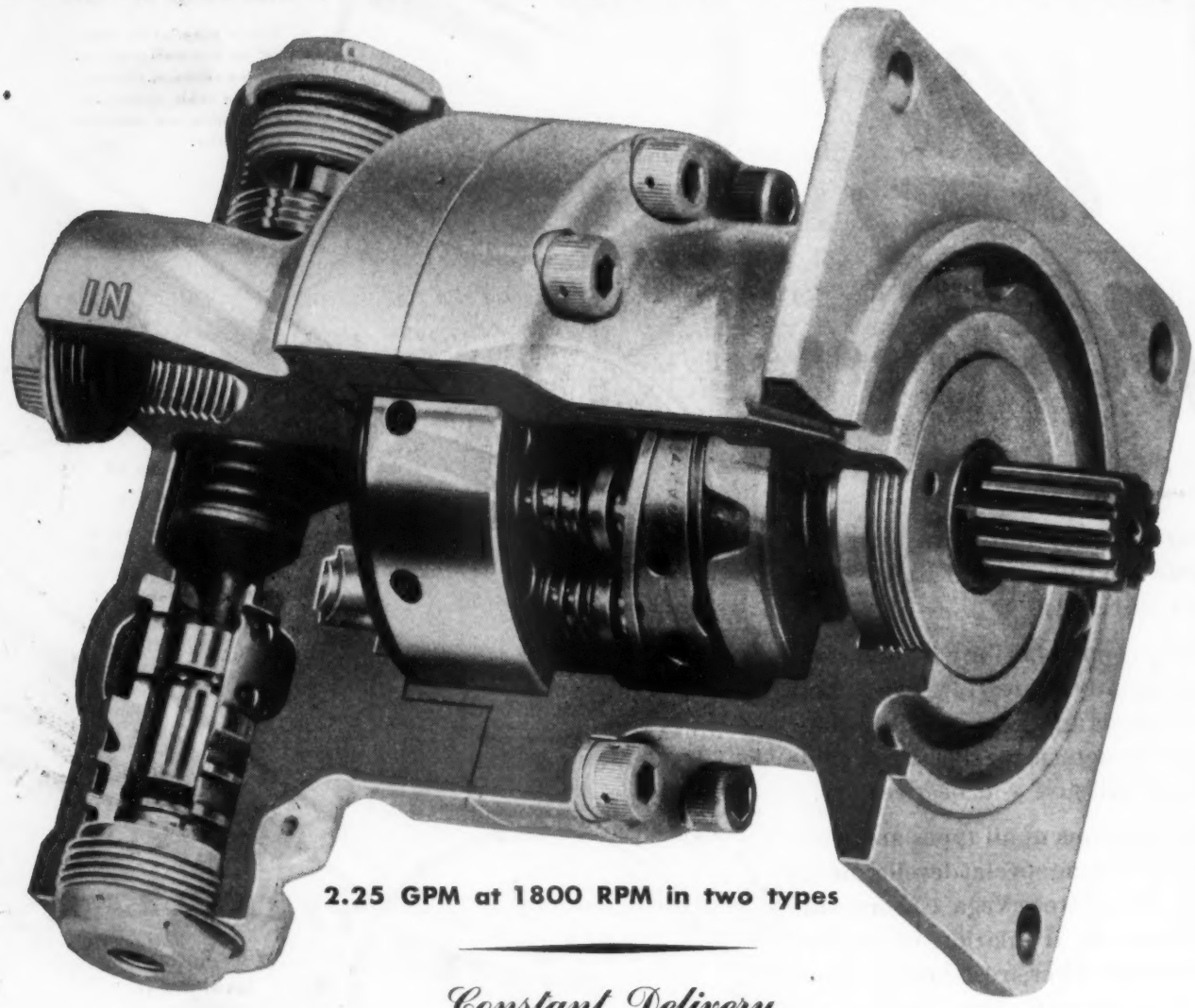
TUNE IN "EVERYTHING FOR THE BOYS" STARRING DICK HAYMES—EVERY TUESDAY NIGHT—NBC NETWORK

HYCON

REG. TRADE MARK

The Stratopower Pump

is now available for Commercial application—at pressures to 3000 p.s.i.



2.25 GPM at 1800 RPM in two types

Constant Delivery
Variable Delivery with Automatic Integral Regulator

Furnished direct motor drive or for base mounting
Quiet—Compact

Engineering and Performance Data on Request

THE NEW YORK AIR BRAKE COMPANY
Hydraulic Division

420 LEXINGTON AVENUE, NEW YORK 17, N. Y. • FACTORIES: WATERTOWN, N. Y.

Heli-Coil INSERTS
TRIPLE THE LIFE OF SPARK PLUG BUSHINGS FOR CONTINENTAL AIR LINES

ROBERT F. SIX
PRESIDENT

CONTINENTAL AIR LINES, INC.
MUNICIPAL AIR TERMINAL
DENVER, COLORADO

February 20, 1945

Mr. Benjamin Sack, President
Aircraft Screw Products Co., Inc.
47-23 35th St.
Long Island City 1, N.Y.

Dear Mr. Sack:

Since operating an airline demands very careful attention to maintenance costs, I was much interested in this report which our Maintenance Department made recently on your Heli-Coil Inserts:

When we were using threaded bronze bushings for spark plugs on our engines, 700 hours was excellent life--and oftentimes the bushings went bad and cylinders had to be pulled long before the 700 hours were up.

Then we began to use the new Heli-Coil Inserts both in repairing cylinders already on engines and as standard installations in bronze bushings in the cylinders of all engines being overhauled. A recent check showed that these inserts are giving an average of 2000 hours of service. Because the use of the Heli-Coil Inserts has resulted in an important saving in man-hours, we are now installing them on all of our engines.

Sincerely yours,

Robert F. Six
President

RFS/lad

2000 hours with Heli-Coil Inserts compared with 700 hours for original bushings

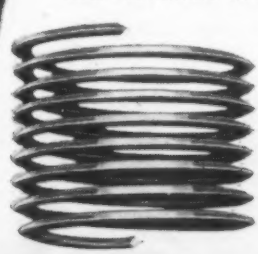
ENGINEERING REPRESENTATIVES

DETROIT
G. C. Brown and A. W. Roeder
201 South Pleasant St.
Royal Oak, Michigan

KANSAS CITY
Pacific Airmotive
1628 McGee St.
Kansas City, 8, Mo.

LOS ANGELES
J. S. Wise
Room 925, Pacific Mutual Bldg
523 West 6th St.
Los Angeles, California

SEND FOR BOOKLET 237A



THE SCREW SYSTEM WITH THE ANTI-FRICTION THREAD LINING

HELI COIL

U. S. and Foreign Patents Issued and Pending

AIRCRAFT SCREW PRODUCTS COMPANY, INC.
47-23 35th STREET • LONG ISLAND CITY, 1, N. Y.

OPERATOR: *"These flexible lines don't break, Fred."*

FOREMAN: *"No! Not since we changed to Titeflex."*

That's the real test of flexible tubing — the length of time it stays on the job — takes constant punishment *without* breakage, *without* leakage — *without* the need for replacement.

And that's the big reason Titeflex is replacing so many types of flexible tubing on so many types of machines.

Illustrated above is a Titeflex line utilized for compressed air on a punch press. But whether your lines convey oil, coolant, water, chemicals, or air — Titeflex will last longer on the job.

What makes Titeflex better? First, of course, the fact that it's *all-metal*, and accordingly is not affected by heat, by cold, or by most corrosive materials. But remember, to this all metal construction, Titeflex adds two exclusive virtues:

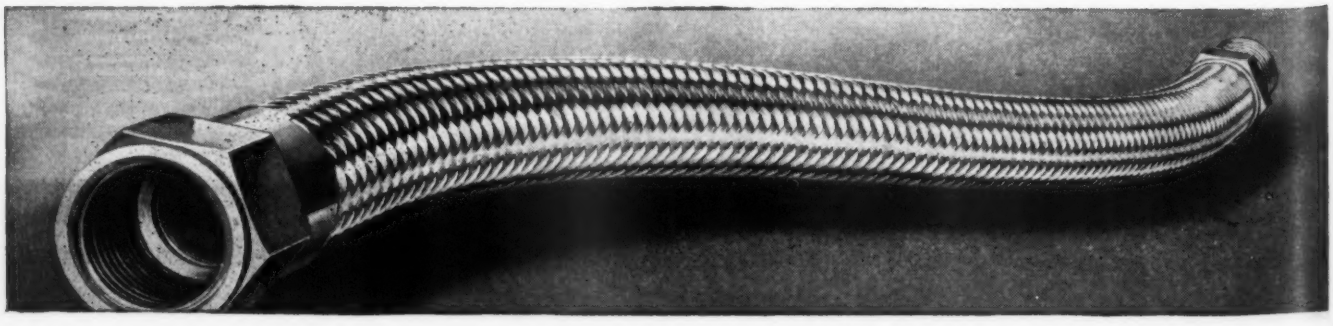
• Titeflex provides not one but four thicknesses of metal at the point of greatest wear. That means greater durability.

• Titeflex metal braiding is woven directly onto the tubing as it is made — never slipped on afterwards. That means greater ability to withstand high pressures, greater protection against elongation.

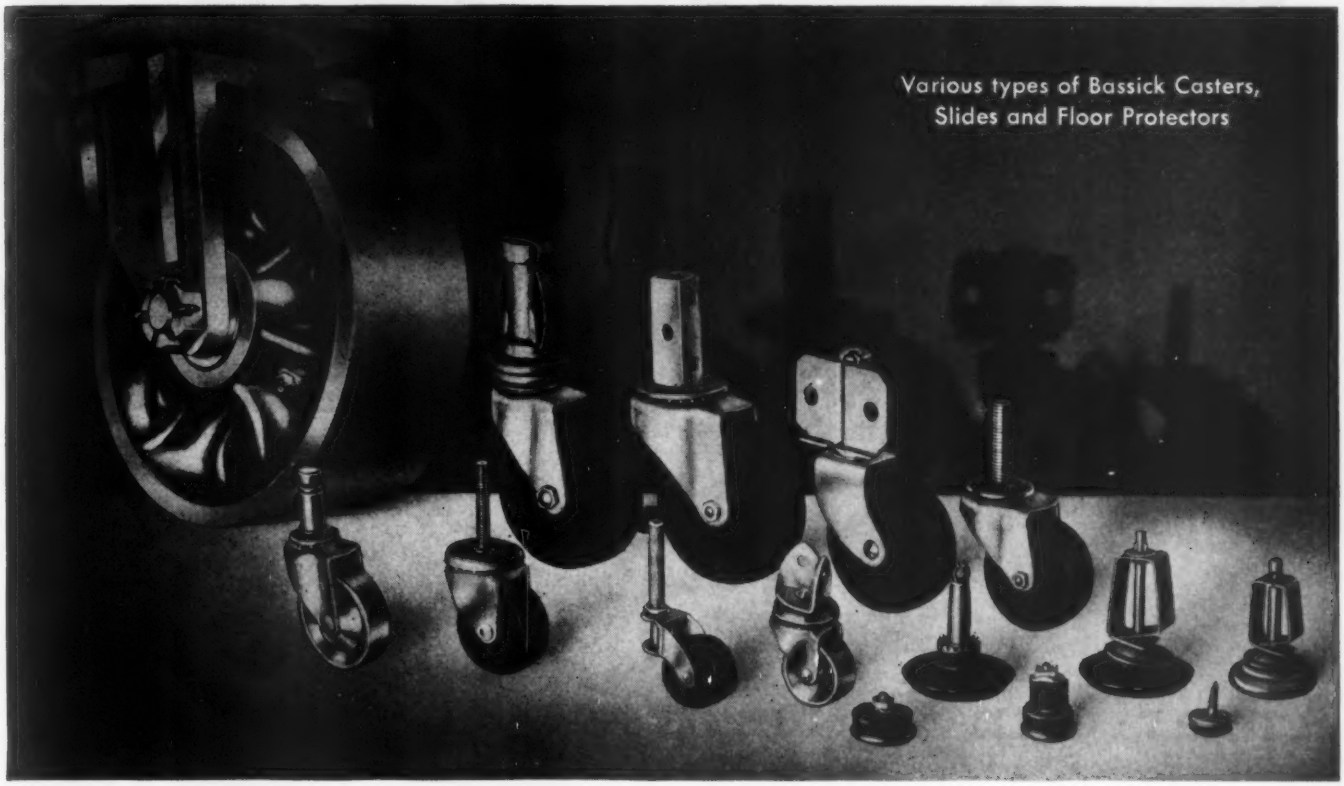
You'll find Titeflex all-metal tubing available in sizes and types to meet every equipment need. Catalog No. 113 gives the information and data you need — both for your present war-time production, and for your post-war planning. May we send your copy — now?

TITEFLEX, INC., 518 Frelinghuysen Ave.
Newark 5, N. J.

Titeflex



MAKE MOBILITY A SALES POINT



Various types of Bassick Casters, Slides and Floor Protectors

Ease of mobility and *protection to floors* are increasingly important factors in the design of any product — industrial, institutional, office or household equipment.

For easy movement and flexibility of handling, put your product on casters. It is a sure way to make that product easier to use, susceptible to wider usage and *easier to sell!*

Good casters can be an important sales advantage.

Many product designers have become acquainted with Bassick for the following reasons. Bassick's line is the most complete — casters for everything from tea tables to heavy trucks, plus all kinds of slides and other accessories.

Bassick-engineered construction features give advantages in ease of operation, quieter operation, protection of floors and equipment, longer caster life. Bassick engineering service helps solve design problems.

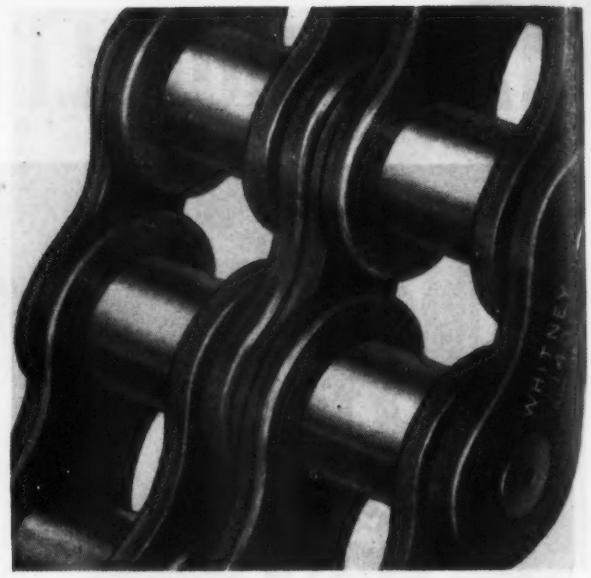
Make mobility a key consideration in your design. It's best to have it in mind while the preliminary sketches are being made, so as to design around standard caster types — but even in a finished design, many varied attachments make it possible to caster-ize present stationary products.

THE BASSICK COMPANY, Bridgeport 2, Conn. Division of Stewart-Warner Corporation. *Canadian Division:* Stewart-Warner-Alemite Corporation, Ltd., Belleville, Ont.

Making more kinds of Casters... Making Casters do more

Bassick

Pulling for Victory



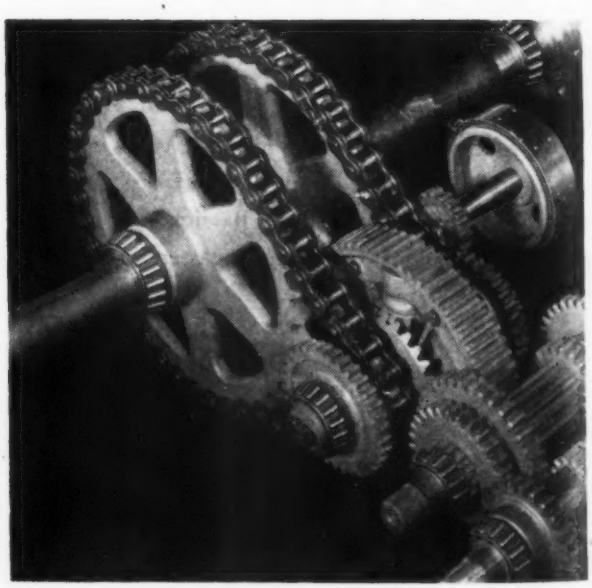
★ ★ ★ ★ ★ ★ ★ ★ ★ ★ ★ ★ ★ ★ ★ ★ ★ ★ ★ ★

American Farmers are breaking all production records

Whitney Roller Chain offers a compact rugged design for tractor final drives. Tractors equipped with Whitney Roller Chains have made many records for performance and dependability under difficult operating conditions.

★ ★ ★ ★ ★ ★ ★ ★ ★ ★ ★ ★ ★ ★ ★ ★ ★ ★ ★ ★

Whitney Chains serve agriculture and every other war industry . . .



The Whitney Chain & Mfg. Co., Hartford, Conn.

Catching Tin Fish

. . . another use for SUPERCHARGING

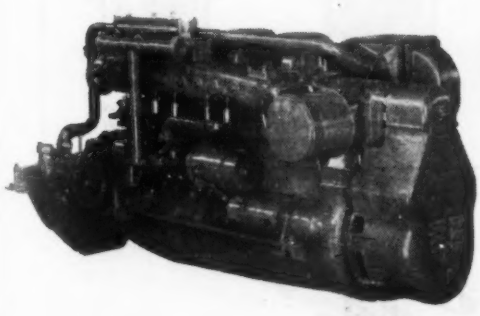
Cleaving through the water at 40 to 50 miles an hour, a torpedo under test is an elusive thing to catch. But caught it must be and is, just before it sinks.

Catching these tin fish and bringing them in to be given their war-heads, is a tough, tricky job of seamanship. It calls for speed . . . maneuverability . . . responsiveness to every change in throttle or rudder.

It is significant that the engines, made by National Supply Company, are B-W (McCulloch) Supercharged.

Providing extra power when power is needed . . . more power in a given space or weight . . . better performance at higher altitudes . . . and with little appreciable increase in weight — B-W Supercharging finds many uses in engines, both gasoline and diesel, for the marine, industrial, transportation, and automotive fields.

This SMRA-6 engine, made by the National Supply Company, is B-W Supercharged to get extra speed, power, and maneuverability with little appreciable increase in weight or cost.

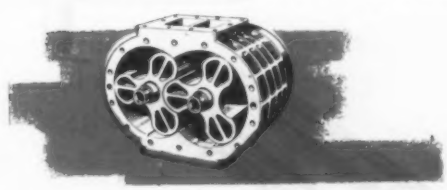


ENGINEERING B-W PRODUCTION

SUPERCHARGERS, INC.

● DIVISION OF BORG-WARNER

Milwaukee 9, Wisconsin



B-W Positive Displacement Superchargers supercharge at all speeds and in proportion to the need of the engine for air.

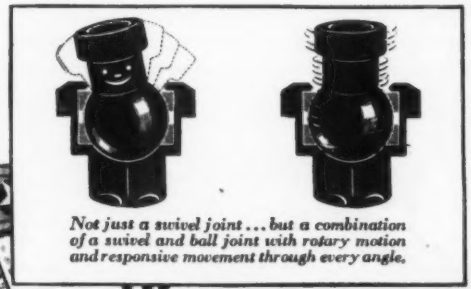
FOR THE ARTERIES OF PRODUCTION

THE ALMOST INDISPENSABLE

BARCO

FLEXIBLE JOINTS

Fluids—oil, gasoline, water, steam—are the very life-blood of America's vast production program. And everywhere throughout industry and transportation, Barco Flexible Joints protect the arterial system which conveys these liquids and gases against vibration, impact and shock. For over 30 years, Barco has led in its field... developing flexible joints for every need. Write for catalogue to the Barco Manufacturing Company, Not Inc., 1827 Winnemac Avenue, Chicago, 40, Ill.



Not just a swivel joint... but a combination of a swivel and ball joint with rotary motion and responsive movement through every angle.

VARD DESIGNS

A COMPLETE LINE OF SMALL ACTUATORS

The torque type actuator projected above is a continuation of the VARD line of fractional horsepower actuators. Last month we showed you the 1/15th h.p. unit. Above is shown the 9/10th h.p. model.

A complete line of this type actuator has been developed in capacities from 1/100 h.p. to 1 h.p., using the 24-28 Volt D C Motors.

VARD can design and build for you any type of geared actuator. If you will furnish us with *specific data* on the job to be done, we can help you—and quick.

VARD INC.

1945

★

IT ALWAYS DID WORK

...but it took the war to make industry realize it!

Sub-contracting is not a war-baby. The automotive industry has long relied upon it. Others, too, but most manufacturers confined their outside purchases to standard components like electric motors, relays, hardware, and so on.

Came the war . . . had it not been for the universal adoption of sub-contracting (even highly specialized parts and assemblies) there's no telling how far back along the road to Victory we'd be.

Why has industry hesitated?

Prime contractors have had conflicting experiences with sub-contracting. Some have hesitated as a result of hearing complaints from others about rejects, falling down on deliveries, lack of integration with production schedules, failure of parts to fit. The *why* is really very simple.

It's a part of the war . . . not the fault of the sub-contracting system. Over night, concerns were asked to convert from some non-essential peacetime product to making parts *for someone else*. They had never worked *for someone else*.

Sub-Contracting new to most war plants

Sub-contracting is one of the toughest assignments in all industry. It calls for a different kind of teamwork . . . ingenuity . . . timing with the other fellow's operation. And most of these American plants found themselves in the sub-contracting business without the sub-contracting *thinking*.

Here at Lewyt, we have a real appreciation for their problem. When the prime contractors for whom we work discuss the shortcomings of some sub-contractors, we try to point out that the integration which they have come to expect from us is a result of long experience in sub-contracting. After all, that's been our business for the past fifty odd years.

Write on your business stationery for 48 page book "Let Lewyt Do It"—the story of the Lewyt organization in pictures. Lewyt Corporation, 60 Broadway, Brooklyn 11, N. Y.

★ ★ ★

A contract manufacturer—expertly staffed to produce complete electronic and mechanical assemblies, component parts and sub-assemblies, to the most exacting requirements.

CONTINUE ☆ BUYING ☆ WAR ☆ BONDS

PROVEN on every Battlefront

NOW READY for Your HYDRAULIC SYSTEM

Greer HYDRAULIC ACCUMULATORS

Here is a simple, small, low-cost accumulator that sets new standards of performance. Greer Hydraulic Accumulators, battle-tested under the severest conditions on military equipment, are now available for your hydraulic system.

Reliable —The cross-section shows the simplicity of construction which accounts for the reliability and low cost of Greer Hydraulic Accumulators. The one-piece chrome-molybdenum seamless steel shell has a completely enclosed synthetic rubber bag with an integrally molded air valve. No welds. No joints. No packing. No air leaks.

Operation—The accumulator is precharged from the regular shop air supply through an inexpensive booster pump, just like a pneumatic tire. Recharging is necessary only every three or four months.

Sizes, Proportions—Standard sizes range from 4 1/8 D by 8 1/16 long for the 1/3 gallon accumulator, to 12 3/4 D by 52 5/8 long for the 25 gallon accumulator. Operating pressures are from 1000 to 3000 psi, depending upon capacity. For larger capacities, multiples of standard sizes may be hooked up in parallel. Shell proportions and shapes may be varied from standard to suit any condition.

Low Cost—The low cost of Greer Hydraulic Accumulators permits the application of hydraulics in highly competitive portable and stationary equipment.

Engineering Assistance—Our hydraulic engineers will gladly help you with your problem. Write.

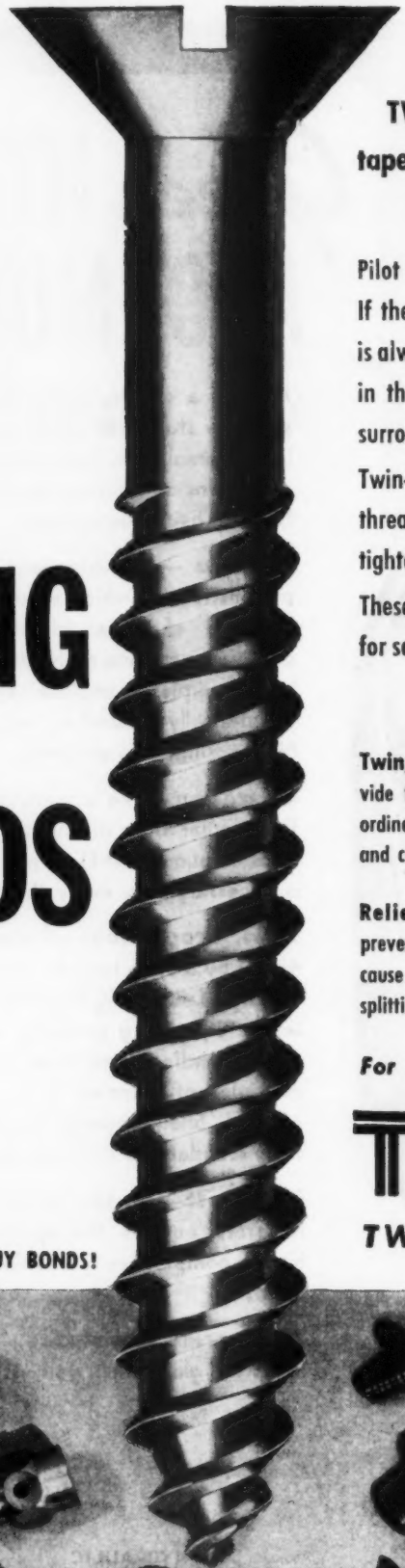
HYDRAULIC POWER

GREER

GREER PRODUCTS CORPORATION

39 West 60th Street, New York 23, N. Y.

NO HANGING THREADS



TWIN-FAST's cylindrical construction (not tapered) means that all threads, right down to the point, cut deeply into the wood

Pilot holes are seldom drilled the precise depth required. If they are too deep, and a tapered screw is used, there is always a danger that threads toward the point will hang in the pilot hole rather than penetrate solidly into the surrounding wood.

Twin-Fast's cylindrical construction not only provides more thread area but assures intimate contact with wood fibres, tighter seating—greater holding power.

These are advantages you cannot afford to overlook. Write for samples of Twin-Fast Screws and make your own tests.

Other Twin-Fast Features

Twin, parallel threads provide twice the thread pitch of ordinary screws. Driving time and costs are cut in half!

Single, sharp, centered point where twin threads terminate assures quick starting, self-centering, balanced driving.

Relieved shank diameter prevents stresses which might cause immediate or eventual splitting or fissures.

Twin-Fast Screws come in steel or brass with round, flat or oval heads—standard sizes and thread count.

For Faster Production—Sounder Construction—

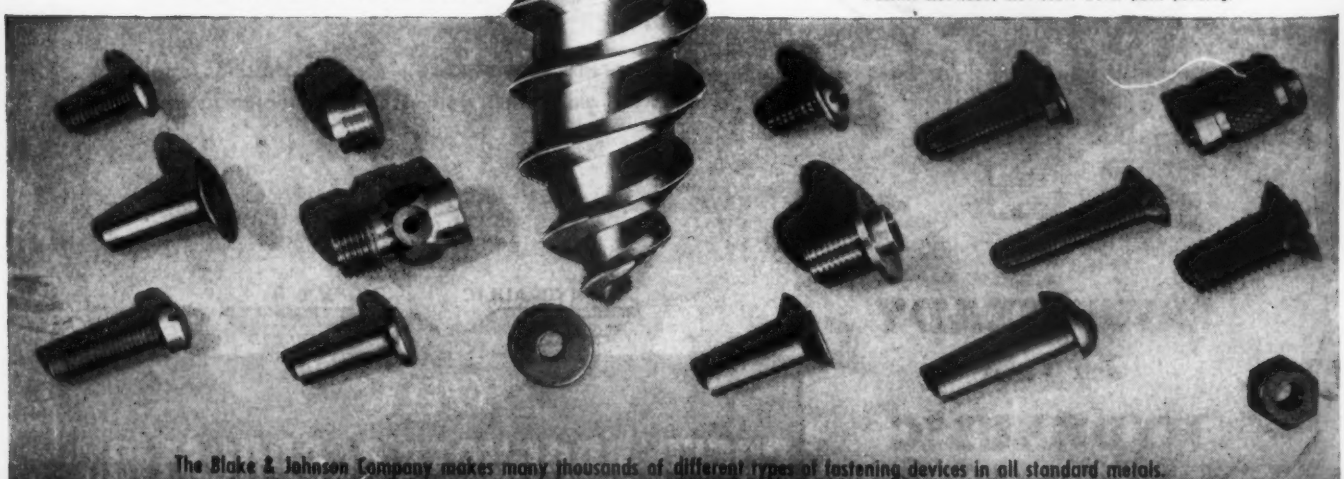
TWIN *fast*

Reg. U. S. Pat. Off.

TWIN THREAD WOOD SCREWS

Patents 2,314,390; 2,314,391. Other pats. pending.

BY ALL MEANS—BUY BONDS!



The Blake & Johnson Company makes many thousands of different types of fastening devices in all standard metals.

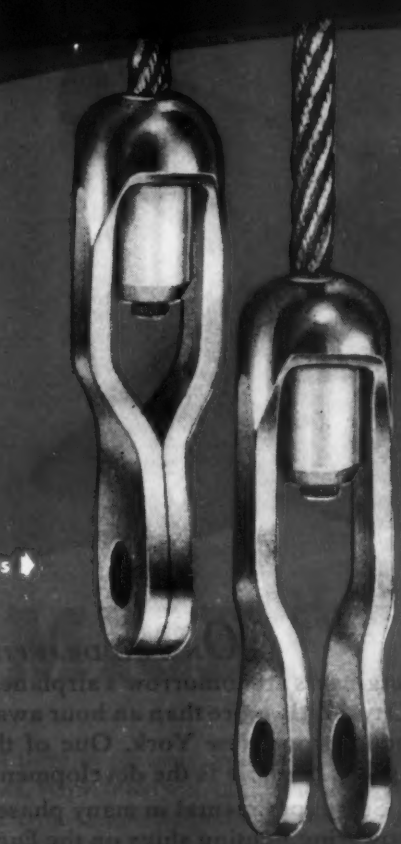
THE BLAKE & JOHNSON COMPANY (Since 1849) WATERVILLE, CONNECTICUT

Save Money WITH P & N SOCKETYPE CABLE TERMINALS

1. SAVE CABLE—SMOOTHER, SAFER Full use of cable—no doubling back. Streamlined design—no bolts, bulges or sharp ends to foul or come loose.

EYE TYPE for 1/16" to 1" cables

2. EASIER TO INSTALL—ANY TYPE OF CABLE Sockatype terminals are swaged* to the cable—the quickest, safest and least expensive method known.



3. STRONGER THAN ANY CABLE Stamped and drawn to close dimensions of 4130 alloy steel, with strength factor greatly in excess of cable.

FORK TYPE for 1/16" to 1" cables

4. CABLE KINKING ELIMINATED Cable end fits smoothly in terminal socket. Cable may turn when load is off—no turning action when load is on.

P&N

ESTABLISHED 1933

POULSEN & NARDON, INC.

Terminal Box 2398 • Los Angeles 54, California

* If swaging equipment is not available, we can furnish die for punch press swaging. For further information, call your P & N Distributor listed below, or write for new folder.

New data book on cable swaging available to industry personnel.

Lee Brothers Industries, Inc.
Aircraft Section, Priory Works,
Arterial Road, Southend-on-Sea,
England

Electrical Distributors, Inc.
Honolulu 10, Hawaii

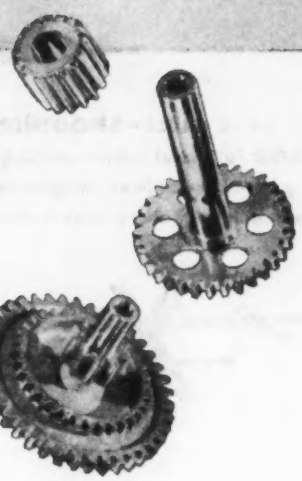
Hawkinsville Auto Supply
Orangeburg, South Carolina

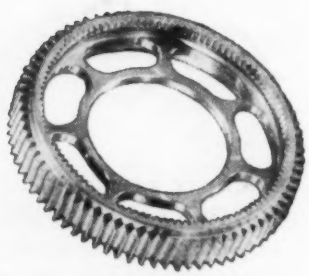
Palmer Aircraft Products Co.
1411 4th Avenue
Seattle, Washington

JET PROPULSION

ANOTHER USE FOR "A-Q" GEARS

AIRCRAFT QUALITY





A copy of this informative product engineering manual on "A-Q" gears will be sent to you on request as soon as it is ready.

On the drafting boards of America's aircraft engineers are tomorrow's airplanes—planes that will bring New York City a little more than an hour away from Chicago—London five brief hours from New York. One of the advances that make these high speeds possible is the development of jet propulsion engines.

Still experimental in many phases, jet propulsion engines are today powering fighting ships on the European front. These engines offered many technical problems to designers, not the least of which was the gears. Because of the exacting demands of precision, light weight and high speed, it was natural for builders to look to Foote Bros. for the solution of this tough problem in gear design and production.

The jet propulsion engine is another example of how "A-Q" gears can aid technological development. These gears may well offer a successful solution to production problems you face on machines and equipment which you are manufacturing or planning to manufacture. Foote Bros.' engineers will gladly discuss with you the problem of producing gears to assure you greater mechanical efficiency, lighter weight, higher speed, greater quietness.

FOOTE BROS. GEAR AND MACHINE CORPORATION
Dept. W, 5225 S. Western Blvd. • Chicago 9, Illinois

FOOTE BROS.

Better Power Transmission Through Better Gears

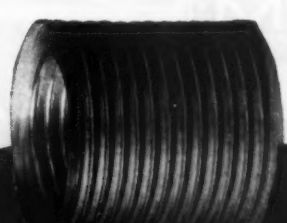
MIGHTY MITE!

THAT TINY OBJECT there in the man's palm—that's a Sylphon Bellows. When fitted with proper heads and charged with a thermo-sensitive liquid it becomes a thermostat—a powerful little "motor" deriving its power from changes in temperature of the confined liquid. Without the liquid charge, the assembly could be used as a pressure "motor." In either case the developed power could be employed to "make" and "break" electrical circuits, open and close valves, dampers, etc. —in fact its usage is virtually without limit.

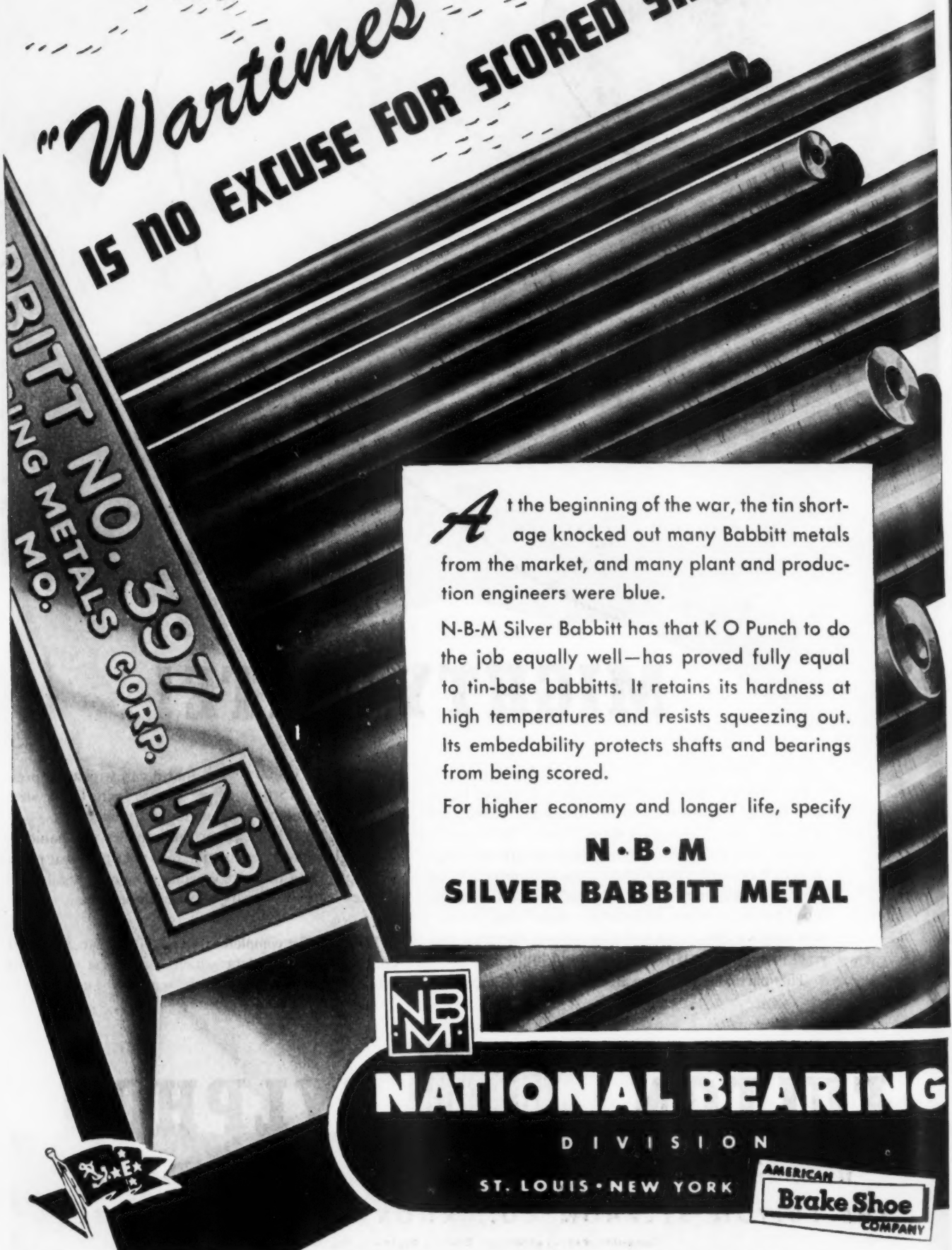
This particular Sylphon Bellows is only ¾ inches in diameter yet it's so rugged that it can withstand pressures up to 315 pounds per square inch. Other sizes and types available for even higher pressures.

Together with its larger and smaller companions, this mighty mite is ready to fit into your post-war plans —simplify and improve existing designs—possibly be the key to revolutionary new developments.

Write for the complete story—Bulletin No. GP-1300 contains valuable data which should be useful to every engineer. A copy will be sent upon request.

FULTON  **SYLPHON**

"Wartimes" IS NO EXCUSE FOR SCORED SHAFTS



At the beginning of the war, the tin shortage knocked out many Babbitt metals from the market, and many plant and production engineers were blue.

N-B-M Silver Babbitt has that K O Punch to do the job equally well—has proved fully equal to tin-base babbitts. It retains its hardness at high temperatures and resists squeezing out. Its embedability protects shafts and bearings from being scored.

For higher economy and longer life, specify

N·B·M

SILVER BABBITT METAL

N·B·M

NATIONAL BEARING

DIVISION

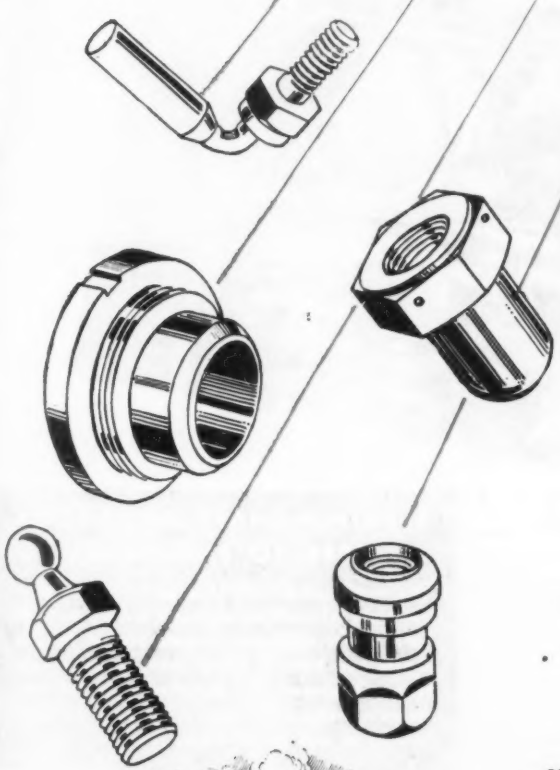
ST. LOUIS • NEW YORK

AMERICAN Brake Shoe COMPANY

PLANTS IN: ST. LOUIS, MO. • PITTSBURGH, PA. • MEADVILLE, PA. • JERSEY CITY, N. J. • PORTSMOUTH, VA. • ST. PAUL, MINN. • CHICAGO, ILL.

SKILL . . .

IN ENGINEERING AND PRODUCTION WORKS FOR YOU AT TOUREK!



It is our business to work for you—to produce screw machine products which fully meet your exact specifications. To do this, we have fully coordinated the vital factors of *engineering "know-how"*. . . . *modern equipment* . . . and *manufacturing experience!*

Precision? Why, it has been a "must" at Tourek for twenty-five years.

Why not consult us *now* about your post-war requirements for screw machine products? All our skill in engineering and production is available to produce for you . . . in any quantity . . . in any alloy . . . and in any size up to 2 5/8".

J. J. TOUREK MFG. CO.

4701 W. 16th Street **Chicago 50, Illinois**

MAKERS OF THE FAMOUS TOUREK BALL JOINTS

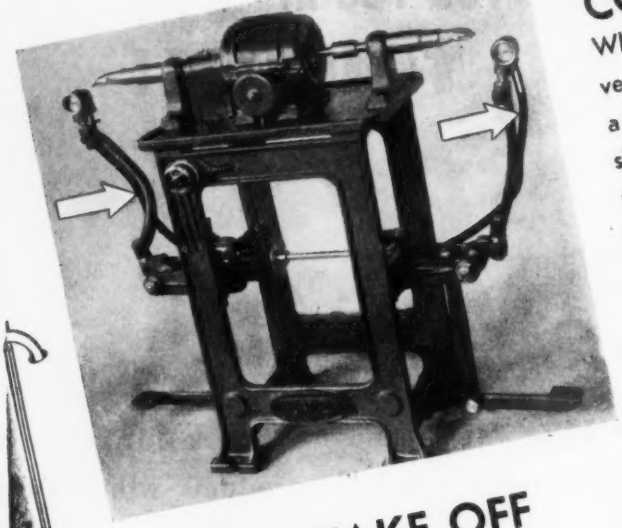
ESTABLISHED 1920

TOUREK

PRECISION SCREW MACHINE PRODUCTS

Ideas FOR DESIGN-ENGINEERS—IN THESE USES OF *S.S.White Flexible Shafts*

ONE OF A SERIES showing typical POWER DRIVE and REMOTE CONTROL applications



COUPLING

with short pieces of S. S. White Remote Control Flexible Shafts can be very helpful in the design and construction of a variety of equipment. In the radio receiver shown below, two pieces of shafting "couple" the outside remote control flexible shafts to their respective tuning elements. The use of coupling shafts gives you wide latitude in the placing of parts and simplifies assembly because it makes accurate alignment unnecessary. Photo courtesy of Philco Corporation.

POWER TAKE OFF

For taking power from one part of a machine to drive another part, S. S. White Power Drive Flexible Shafts are always worth considering. In the felt hat clipping machine shown above, the flexible shafts connected to the countershaft, drive the two movable feeder rolls which revolve the hats. Comparison with other possible means for driving these rolls will make clear the simplicity and easy application of the flexible shaft method. Photo courtesy of Turner Machine Co., Inc.

FLEXIBLE SHAFT HANDBOOK FREE TO ENGINEERS

This newly published 256-page handbook gives complete information and engineering data on both power drive and remote control flexible shafts and how to apply them. A copy, free to any engineer who complies with this provision — make your request on your business letterhead and indicate your position.

S.S.WHITE INDUSTRIAL DIVISION

THE S. S. WHITE DENTAL MFG. CO.

DEPT. D 10 EAST 40th ST., NEW YORK 16, N. Y.

FLEXIBLE SHAFTS — AIRCRAFT ACCESSORIES
MOLDED PLASTICS
MOLDED RESISTORS — FLEXIBLE SHAFT TOOLS

One of America's AAAA Industrial Enterprises

Giant rubber-pad Airplane press uses Oilgear Fluid Power for all motions. Tables travel up to 3 feet per second yet accelerate and decelerate without jar. All functions together with selective sequence obtained simply with standard equipment. Tables can be brought under press as loaded. No waiting, no delay. Proved dependable trouble-free performance.

AND STEP UP PRODUCTION

Oilgear helps designers to get full press production capacity

Plane part plant after plane part plant is converting to these new Oilgear-powered 2½-, 3-, and 5-thousand-ton presses . . . selective or sequence loading and feeding on the 4-way shuttle tables are cutting down press non-productive time and boosting output tremendously. Oilgear's role is to provide the flexible, controllable power that makes such operations possible.

Sheet metal to be formed and dies are set up on table unsecured, the table accelerates smoothly so as not to disturb the set-up, travels as high as 3 feet per second, decelerates without jar under the rubber-pad press, and, after the forming operation, withdraws, its place taken by another loaded table. All operations are controlled automatically and remotely. Yet sequence can be varied at will to let tables feed under the press as fast as they are loaded, and all functions are obtained with simple, standard Oilgear equipment.

Flexible, versatile, adaptable Oilgear Fluid Power offers many other advantages too, all of them applicable to giant and midget machines alike. Forward-looking builders and users of machines and processes cannot afford to overlook these advantages. Find out from Oilgear engineers what Oilgear can do for you. Write today. . . . THE OILGEAR COMPANY, 1311 West Bruce Street, Milwaukee 4, Wisconsin.

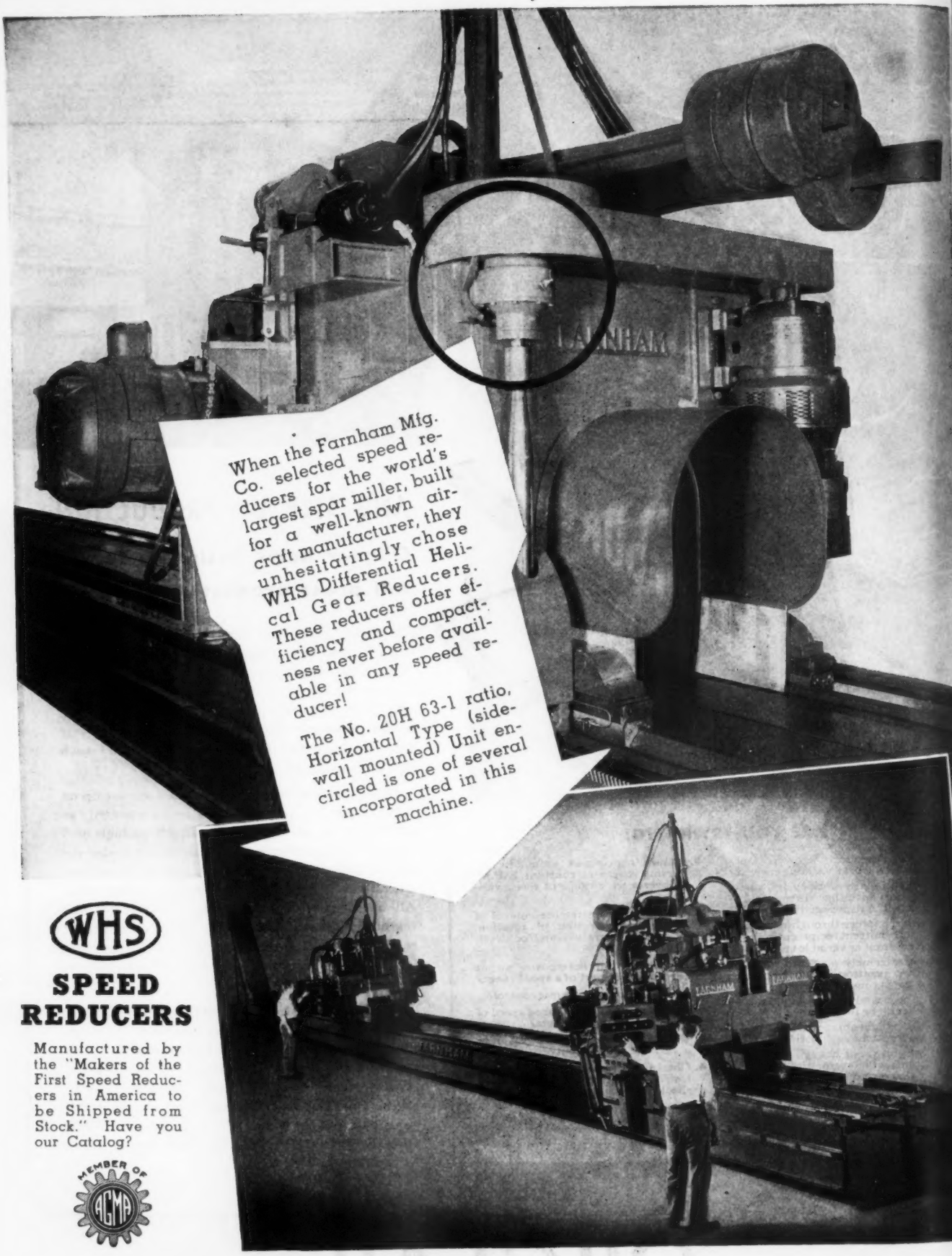
ARE YOU TRYING TO:

1. Apply large forces through long . . . or short . . . strokes at variable speeds?
2. Obtain automatic work cycles, variable speeds in either direction . . . with or without pre-set time dwell?
3. Apply large forces through continuous or intermittent reciprocating cycles at constant or variable velocities?
4. Obtain extremely accurate control of either position or speed of a reciprocating member?
5. Apply accurately variable pressure either static or in motion?
6. Closely synchronize various motions, operations or functions?
7. Apply light . . . or heavy . . . forces at extremely high velocities through either long or short distances of travel?
8. Obtain continuous automatic reversing drives at constant R.P.M. or over a wide range of speed variation?
9. Obtain accurate remote control of speed and direction of rotation, rates of acceleration and/or deceleration?
10. Obtain constant horsepower output through all or part of a speed range?
11. Obtain automatic torque control?
12. Obtain accurately matched speed of various rotating elements?
13. Obtain constant speed output from a variable speed input?
14. Obtain full pre-set automatic control, elimination of problems of shock, vibration, etc.?

You Need Oilgear!

OILGEAR

Fluid Power



When the Farnham Mfg. Co. selected speed reducers for the world's largest spar miller, built for a well-known aircraft manufacturer, they unhesitatingly chose WHS Differential Helical Gear Reducers. These reducers offer efficiency and compactness never before available in any speed reducer!

The No. 20H 63-1 ratio, Horizontal Type (side-wall mounted) Unit encircled is one of several incorporated in this machine.

WHS

SPEED REDUCERS

Manufactured by the "Makers of the First Speed Reducers in America to be Shipped from Stock." Have you our Catalog?

MEMBER OF AGMA

WINFIELD H. SMITH, Inc.

111 EATON STREET, . . . SPRINGVILLE . . . ERIE COUNTY . . . NEW YORK

THE PAST FORETELLS THE FUTURE

Your copy of this fine book is now ready. You will want it as a guide for the future.

The best guide for your future relations with a man is his reputation in the past.

So it is with business institutions.

Today, more than ever before, every individual business must depend on other individual businesses. And that dependence can, and should, be placed only upon those business institutions whose record of performance as to policy, product, service and general attitude has been flawless in the past.

Many new businesses exist today. Many others, old in years, have not kept young in thinking . . . and are passing from the national picture. This has been the history of business since the world began.

Yet, through all the economic changes, certain institutions have grown old in years, but have kept young in spirit and have constantly improved upon their original reason for existence.

The book illustrated above deals with the history of The Falk Corporation, its ideals, accomplishments, and plans for the future so far as those plans can now be projected.

You, too, in your effort to render a service to your industry, must of necessity have followed many of the principles set forth in this book. For that reason we believe that the book will interest you and will provide you with reasons why The Falk Corporation will be a sound source of supply for the machinery you will need to shave pennies from production costs and improve your product, in order to compete in the salesmen's war to come.

THE FALK CORPORATION, *Milwaukee 8 Wisconsin*

ALWAYS PAYS TO CONSULT **FALK** . . . A GOOD NAME IN INDUSTRY

For over fifty years Precision Manufacturers of

Speed Reducers • Motoreducers • Flexible Couplings • Herringbone and Single Helical Gears • Heavy Gear Drives
Marine and Diesel Engine Gear Drives and Clutches • Steel Castings • Contract Welding and Machine Work.

District offices, representatives, or distributors in principal cities.

Your Future Designs Should Include

RBC NEEDLE BEARINGS

AND HERE ARE THE REASONS WHY!

If your post-war designing includes anti-friction bearings, be sure you specify not only the bearing that will best carry the load, but the bearing that is easiest to mount.

Notice in the illustration the generous radii on all corners, particularly the bore radii, so important in guiding the shaft to its precise location as the machine is assembled.

Observe also, the integrality of the ends and the body of the race which immunize the bearing from assembly accidents in the plant and reassembly difficulties in the field.

Refinements like these are typical of this company, which has pioneered for more than a decade in the development and perfection of NEEDLE BEARINGS which combine higher load capacity and smaller overall dimensions. Evidences of success are the many installations of RBC NEEDLE BEARINGS that have given years of dependable, trouble-free service.

RBC MORE THAN 25 YEARS EXPERIENCE

If You Have a Weight or An Endurance Problem, Please Consult Our Engineering Staff

ROLLER BEARING CO. OF AMERICA
TRENTON, NEW JERSEY

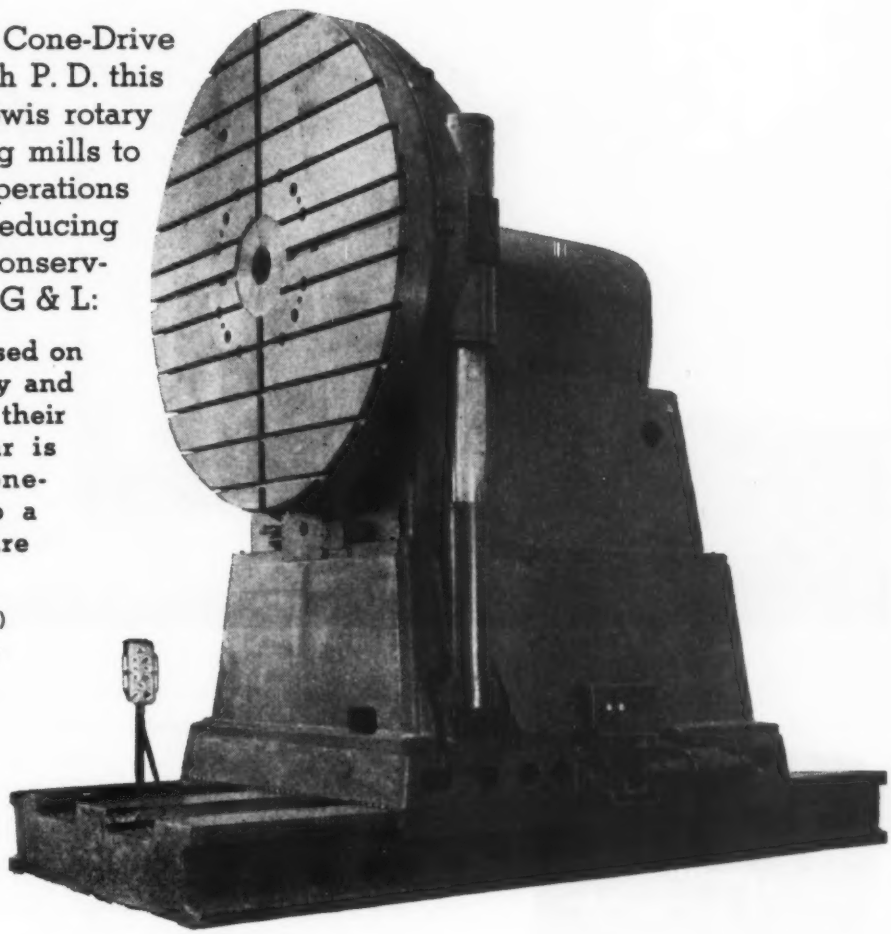
CONE-DRIVE OPERATED G & L ROTARY TABLE CUTS 45 SET-UPS TO 4

Operated through five sets of Cone-Drive gearing, ranging up to 96 inch P. D. this power-drive Giddings and Lewis rotary table enables horizontal boring mills to perform an endless variety of operations in a single machine setting, reducing machine tool investment and conserving floor-space. According to G & L:

"The Cone-Drive gears were used on account of the high load capacity and the high reserve strength, and their reliable performance. As wear is greatly reduced with the Cone-Drives, the backlash is held to a minimum". Cone-Drive gears are used to:

1. **Rotate the vertical table (96" P. D.)**
2. **Operate the feed drive for the rotary table and base.**
3. **Operate the rapid traverse for table and base.**
4. **Operate traverse assembly (2 sets).**

In one plant gun mounts are now produced in four set-ups instead of 45, by use of this table.



If you do not know the story of why Cone-Drive gearing will outperform any other type of right angle gearing, write for bulletins

CW-41A—For Design Engineers
CW-41B—For Executives
745—A Post-Graduate Course for Gears

CONE-DRIVE DIVISION **MICHIGAN TOOL COMPANY**
7171 E. McNichols Rd., Detroit 12, U.S.A.

100 CASE HISTORIES

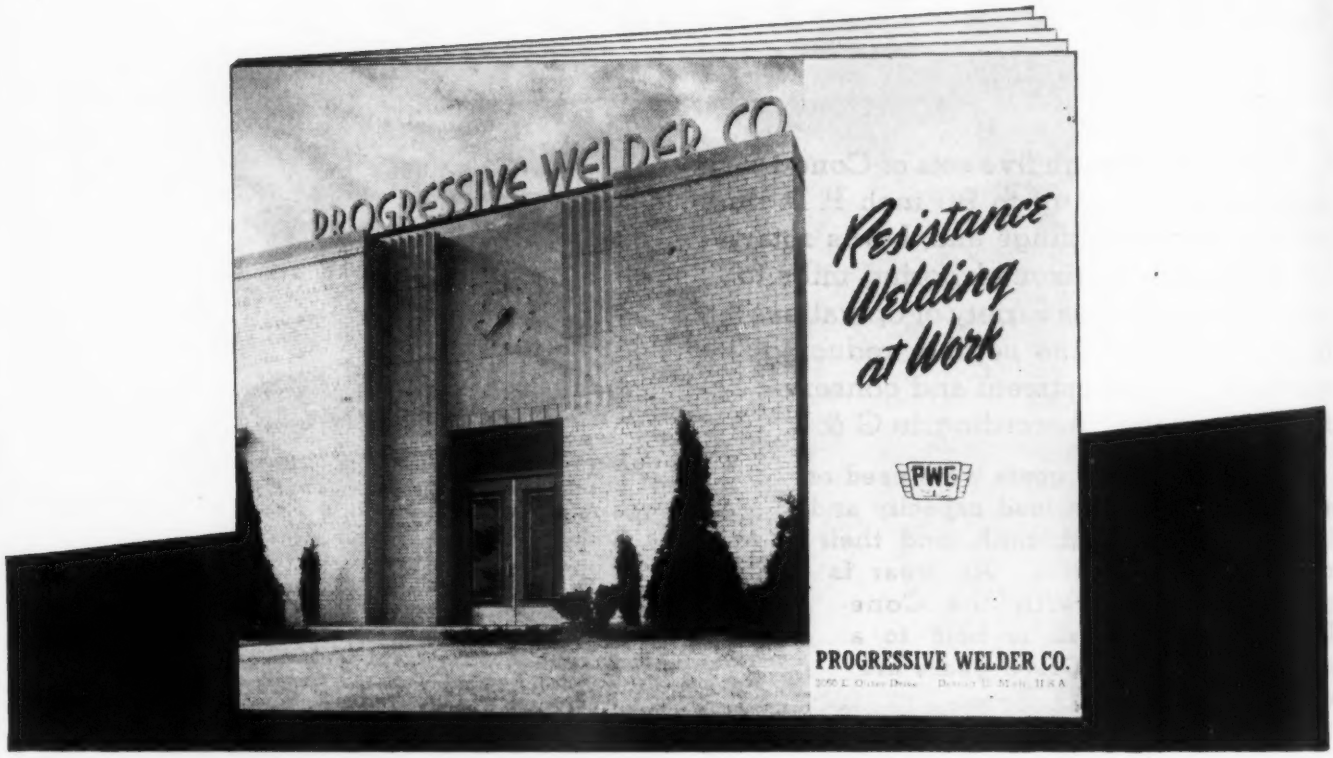
of typical applications in Industry of

"PORTABLE" WELDING

1. Portable machines
2. Push guns
3. Scissors guns
4. "C" type guns
5. Pinch type guns
6. Special guns
7. Portable Seam Welders

"STATIONARY" WELDING

1. Pedestal Spot welders
2. Rocker arm welders
3. "Temp-A-Trol" welders
4. Projection welders
5. Multi-spot welders
6. Seam welders
7. Special Uses of Welders



Write for your copy on your Company Letterhead. Ask for it by name. "RESISTANCE WELDING AT WORK" or by number WP-44

On all kinds of industrial products: automobiles, stoves, refrigerators, containers, aircraft, etc. . . . All kinds of metals: aluminum, stainless, carbon steels, alloy steels . . . In heavy gages and light gages . . . On all kinds of shapes.

Plus a section on Welding & Assembly Fixtures

No metal fabricating plant should be without one of these idea-provoking 60-page books . . . the story of *how* resistance welding can be and is being used to simplify construction, cut costs, speed production and improve the value of finished products. Includes many new uses developed as a result of the war.

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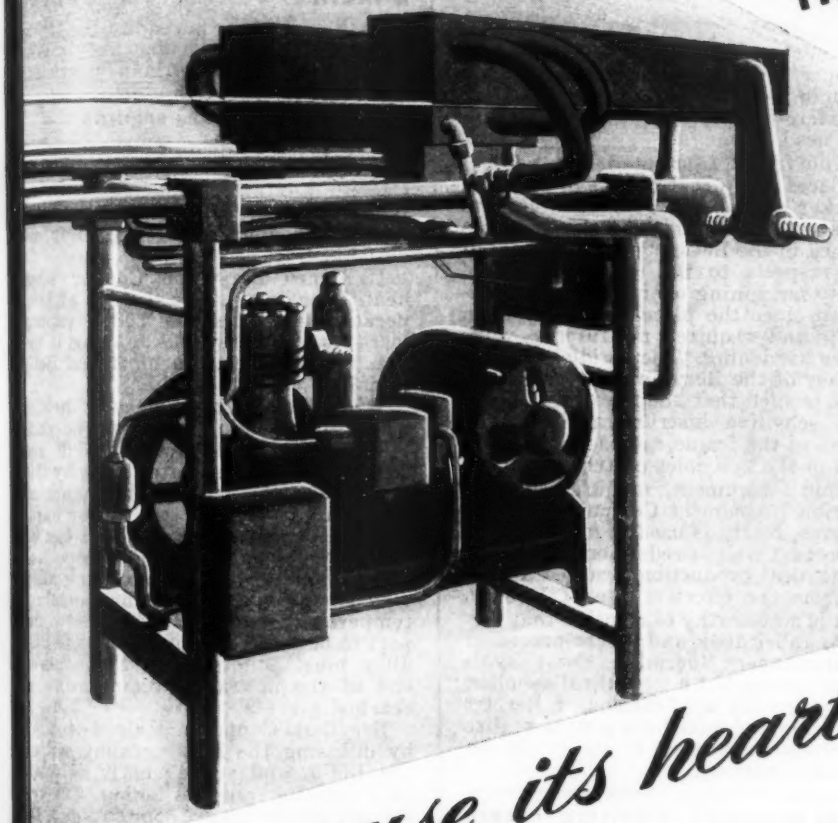
SEAM PROJECTION & BUTT • *Electric Welding Equipment* • PORTABLE GUN & PEDESTAL

3050 E. OUTER DRIVE • DETROIT 12, U. S. A.

THE TUBE IS THE HEART OF THE HOSE—INSIST UPON ITS BEING MADE OF COMPAR

A RESISTOFLEX REFRIGERANT LINE NEVER ROTS OR SWELLS —NEVER SHRINKS OR FAILS THROUGH VIBRATION



. . . because its heart is compar

The extensive use of Resistoflex hose as a refrigerant line is due to its corrosion-resistant compar tube. For compar —famous in industry for its complete immunity to the attack of all organic solvents — is equally *impervious to all anhydrous refrigerants except ammonia.*

That is why Resistoflex refrigerant lines never swell or shrink to choke off flow...never rot or slough off to clog equipment. Even constant vibration leaves Resistoflex refrigerant assemblies unharmed.

RESISTOFLEX

RESISTOFLEX CORPORATION, BELLEVILLE 9, N. J.

The I-S SPRINGBOARD

VOL. 2 NO. 1

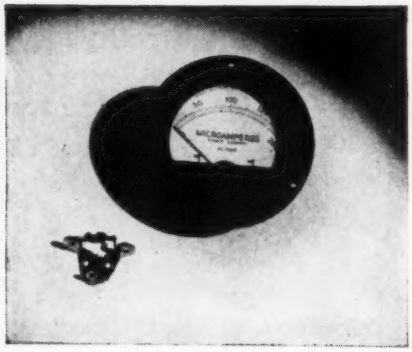
Published by INSTRUMENT SPECIALTIES CO., INC.

234 BERGEN BOULEVARD — LITTLE FALLS, NEW JERSEY

FILEWORTHY FACTS ABOUT MICRO-PROCESSED BERYLLIUM COPPER

INSTRUMENT FRAME FORMED FROM BeCu^{mp} ELIMINATES DIE CASTING MACHINING COSTS

Marion Instrument Company utilizes ability to obtain maximum use of properties of Beryllium Copper



The instrument frame illustrated here is a typical example of the profitable use of micro-processed Beryllium Copper to obtain lower production costs, lighter weight, and close tolerances.

Beryllium Copper was indicated initially because of its non-magnetic properties and its ability to be formed in the annealed or soft state to obtain the intricate shape required. Desired high strength and stability is obtained by proper hardening heat treatment after forming — an inherent characteristic of micro-processing by Instrument Specialties Company.

This frame, fabricated from BeCu^{mp}, replaces a die casting which required thicker sections of greater weight to obtain equal strength. Tolerances obtained in the BeCu^{mp} part are equal in all respects to the die casting, and many machining operations are eliminated since the piece is formed from strip and requires no further work after hardening. The rigidity and accuracy of the Beryllium Copper structure is such that the main bearing of this sensitive instrument spans the width of the frame, and is held in position in the two holes clearly seen.

This instrument, manufactured by Marion Instrument Company of Manchester, N. H., is used in aviation, and important weight reductions as well as economical production resulted directly from the effective use of BeCu^{mp}.

It is noteworthy to mention that this part, fabricated and micro-processed by Instrument Specialties Company, is not a spring, but a structural member. Many similar applications of BeCu^{mp} are being and have been used to realize otherwise impossible or too costly design innovations.

WHAT MICRO-PROCESSING ADDS TO THE INHERENT PROPERTIES OF BERYLLIUM COPPER

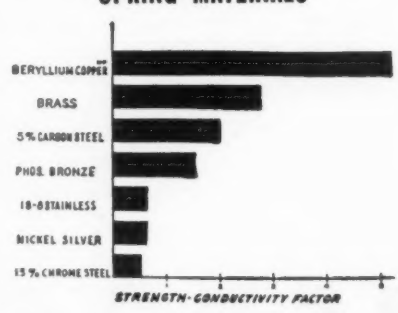
Beryllium Copper is a non-magnetic alloy, with the corrosion resistance of copper and the ability to be hardened by heat treatment. These properties are inherent with the alloy and are available to all users. Of chief value to the spring user, however, are those properties developed by micro-processing: high electrical conductivity, high stability, freedom from drift, endurance strength and close dimensional control in the finished spring.

These properties will not all reach their maximum at the same time at standardized temperature, and the temperature itself has a marked effect on the final properties obtained. Instrument Specialties Company maintains a complete engineering department and laboratory who will be glad to assist you in deriving maximum benefit from micro-processing applied to any individual problem or requirement.

LITERATURE

A few reprints are still available of the technical article "Making Beryllium Copper Behave," by R. W. Carson. This article included the first disclosure regarding heat treat forming to obtain predictably closer tolerances. A copy will be sent upon request.

MICRO-PROCESSED BERYLLIUM COPPER OFFERS THE HIGHEST STRENGTH AND CONDUCTIVITY COMBINATION OF ALL SPRING MATERIALS



Beryllium Copper is the only high strength spring material which also has good electrical conductivity. The steels have low conductivity although the spring strength is high, while the alloys offering better electrical conductivity are much weaker spring materials when compared with BeCu. Micro-processing offers the highest possible electrical conductivity with high strength.

FROM THE I-S LABORATORY

BRAZING BERYLLIUM COPPER

Beryllium Copper is readily brazed by commercial silver solder and a good union is obtained without particular difficulty.

BRAZING BeCu SPRINGS

The above method, however, is not advisable for assembling Beryllium Copper springs, since the brazing temperature is so high that most of the spring qualities of the alloy are destroyed.

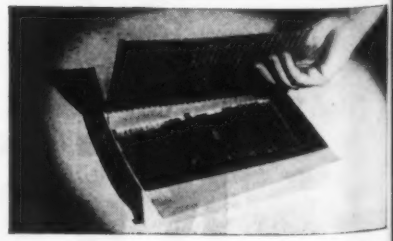
Hardened Beryllium Copper when heated for even a few seconds at temperatures in excess of 800°F rapidly loses its hardness, thus making it impracticable to braze a hardened BeCu spring.

When Beryllium Copper is heated prior to hardening it should be done in the range of 1425° to 1475°F and quenched rapidly in water. Only by this means can the maximum amount of Beryllium be made available for hardening. Therefore, a BeCu part can be hardened to fair spring properties after brazing by using a brazing alloy which melts at the top of the annealing temperature range. But, to allow the part to be water-quenched, the brazing alloy must solidify before the lower end of the annealing temperature is reached.

Beryllium Copper may also be brazed by diffusing the brazing alloy within the BeCu, and subsequently solution heat treating and hardening. The resultant properties are comparable with those usually obtained when annealed BeCu is hardened.

These special techniques require extremely accurate control for successful results, and often involve the solution of allied problems which render them difficult to apply. Usually brazing is used only when no other ready means of assembly is feasible.

No-Tangle Packing Reduces Assembly Costs



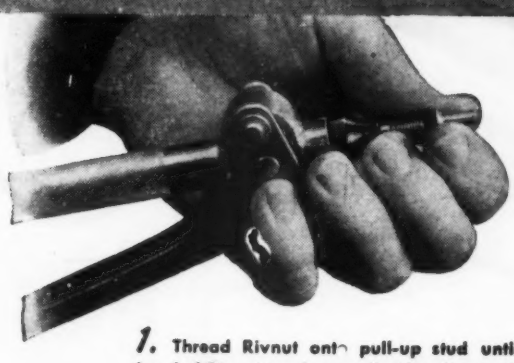
Because of the open pitch design, brush springs for small motors have always been subject to tangling in shipment. This usually results in a costly sorting operation and inevitable damage to a percentage of the springs.

After extensive field tests, I-S has made available the package illustrated to keep springs separate during shipment. Because of the low cost of this packaging method, an appreciable cost saving to the user is possible.

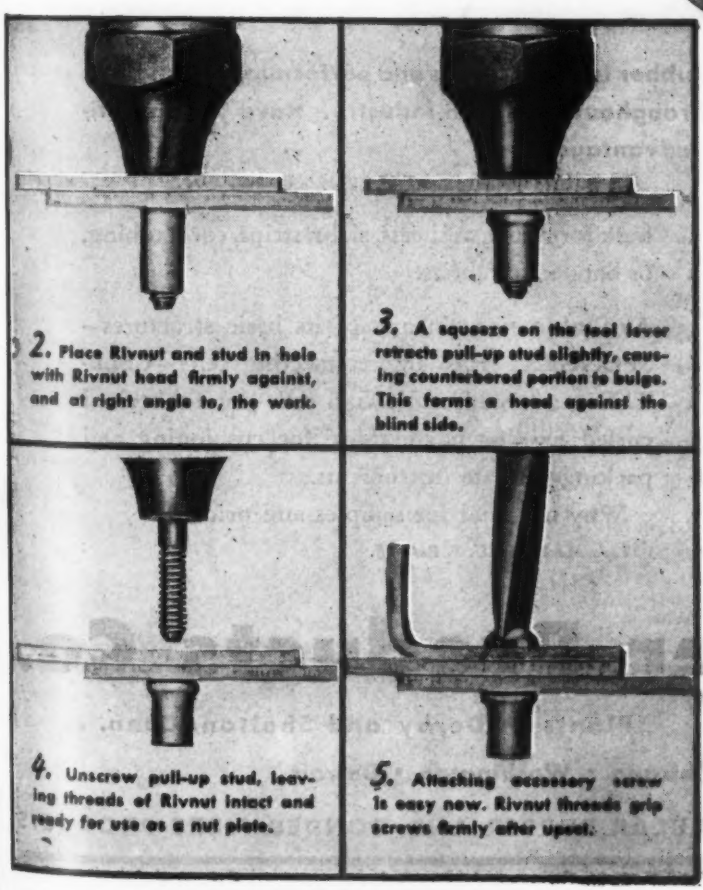
ONE-PIECE
B. F. Goodrich RIVNUT
may solve your fastening problem

Use it as a blind rivet . . . as a nut plate for attachment . . . or both

INSTALLATION IS EASY AS A-B-C



1. Thread Rivnut onto pull-up stud until head of Rivnut touches anvil of heading tool.



2. Place Rivnut and stud in hole with Rivnut head firmly against, and at right angle to, the work.

3. A squeeze on the tool lever retracts pull-up stud slightly, causing counterbored portion to bulge. This forms a head against the blind side.

4. Unscrew pull-up stud, leaving threads of Rivnut intact and ready for use as a nut plate.

5. Attaching accessory screw is easy now. Rivnut threads grip screws firmly after upset.

RIVNUTS are simple little hollow rivets with tremendous utility. You can fasten *with* them; you can fasten *to* them; you can do both at the same time with a Rivnut . . . and all *while working entirely from one side!*

This utility—coupled with low cost, light weight, adequate strength, and really *simple* installation—makes the Rivnut a practical solution to many tough attachment problems.

Rivnuts are headed with an easily operated hand tool. As shown, a ring-type bulge forms on the blind side. This bulge (or upset) is large enough to resist being pulled through the work, even under conditions of eccentric load.

Other advantages are the small hole required, the unusually wide bearing surface, the fact that Rivnuts can be used in wood, metal or plastics.

Steel, aluminum, brass and splined aluminum Rivnuts are available. And many sizes, types, grip ranges. When special Rivnuts are needed, B. F. Goodrich engineers can work out designs with you.

FREE! NEW 40-PAGE EDITION ..."RIVNUT DATA BOOK"

The Rivnut story is interesting . . . and it's all in this book, with pictures. For the facts about this fastener, get "Rivnut Data" now. Write to The B. F. Goodrich Company, Dept. PE-4, Akron, Ohio.

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SPACE FILLING
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DUST PROOFING
•
SHOCK ABSORPTION
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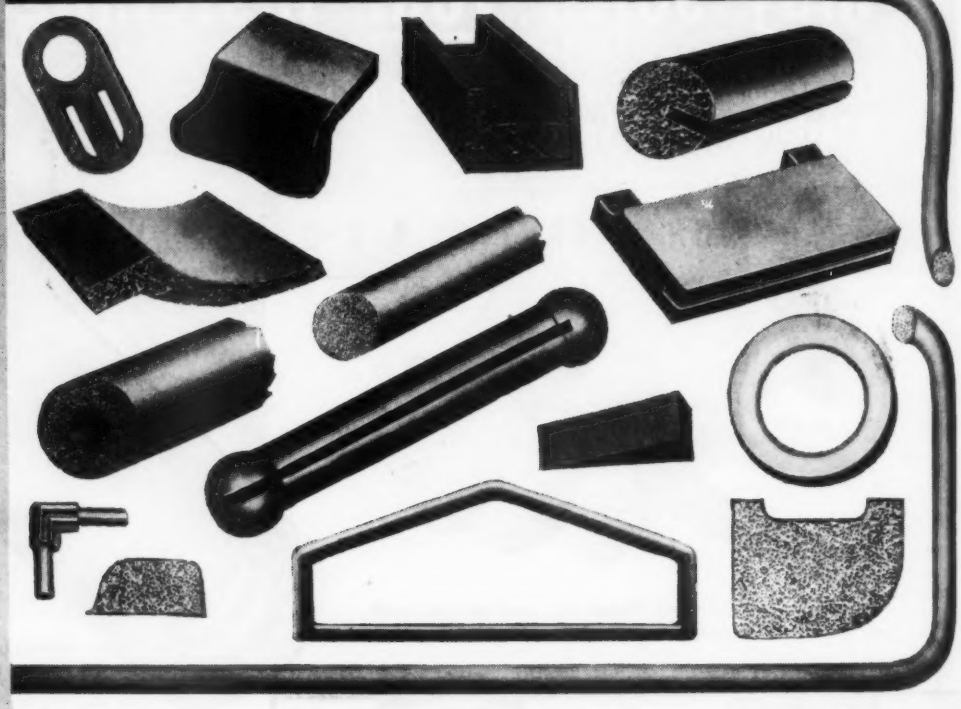
PROTECTIVE PACKING



Cellular Rubber is going places and performing worthwhile service throughout American industry. Have you investigated its advantages?

The unique properties of this modern material – due to its cellular structure and control of its weight and strength, and, where needed, its inbuilt resistance to oils, electricity, chemicals, oxidation and abrasion – result in a decided superiority for hundreds of applications.

To fit your needs – Cellular Rubber is compounded and produced to order in practically any form – molded to shape, in die cut designs, or in bulk form such as sheets, slabs, strips, cord, tubing, or bonded to fabrics.

Available now in any of its basic structures – SPONGEX* with interconnecting cells – CELLTITE* *soft* with individual cells – or rubberized curled hair or bound fibre for cushioning and packing delicate instruments.

Why not send for samples and prices?

**Trade Mark Reg. U. S. Pat. Off.*

Sponge Rubber Products Co.

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Sales Offices: **New York • Chicago • Washington • Detroit**

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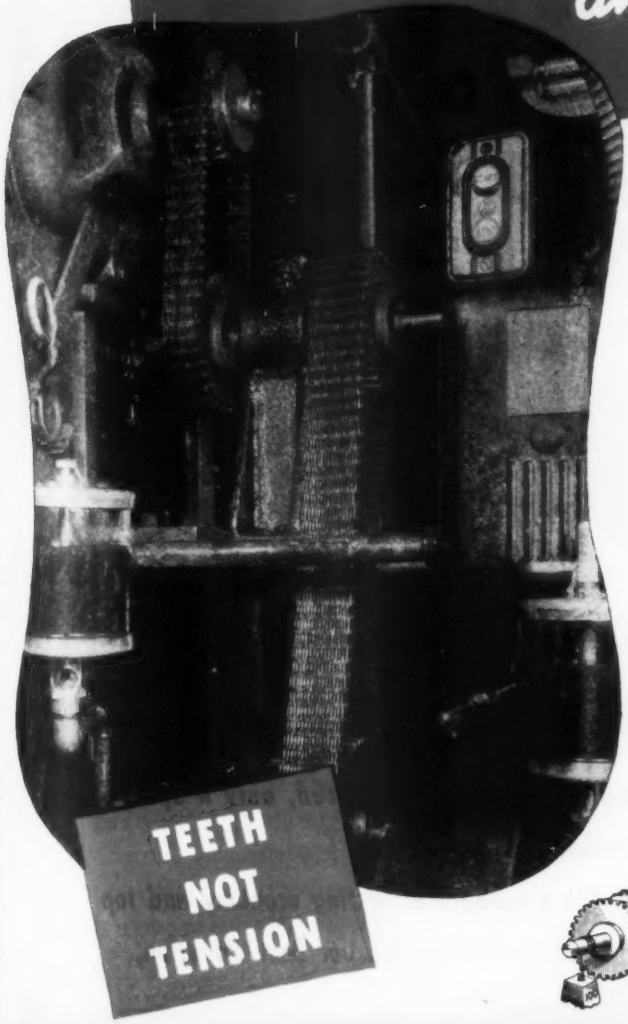
CHAIN Drives work for you—profitably!

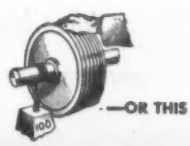
The correct application means maximum machine efficiency and quality output



On mighty or minute installations, for slow or mile-a-minute chain speed, indoors or out, there's a Morse Chain Drive, Silent or Roller, to do the job *better!* For *teeth*, not *tension*, turn the wheels!

That's why Morse Chains are so efficient, so flexible in adaptation and operation. In countless applications, such as that pictured, Morse Chains are delivering up to 99.4% efficiency, smoothly and quietly.

Famed for their capacity to take severe overloads with unvarying smoothness *without slippage*, Morse Chains give a long life of economical, trouble-free operation. Get full information from the Morse engineer near you—or write direct to Morse, Ithaca, N. Y., or Detroit 8, Mich.



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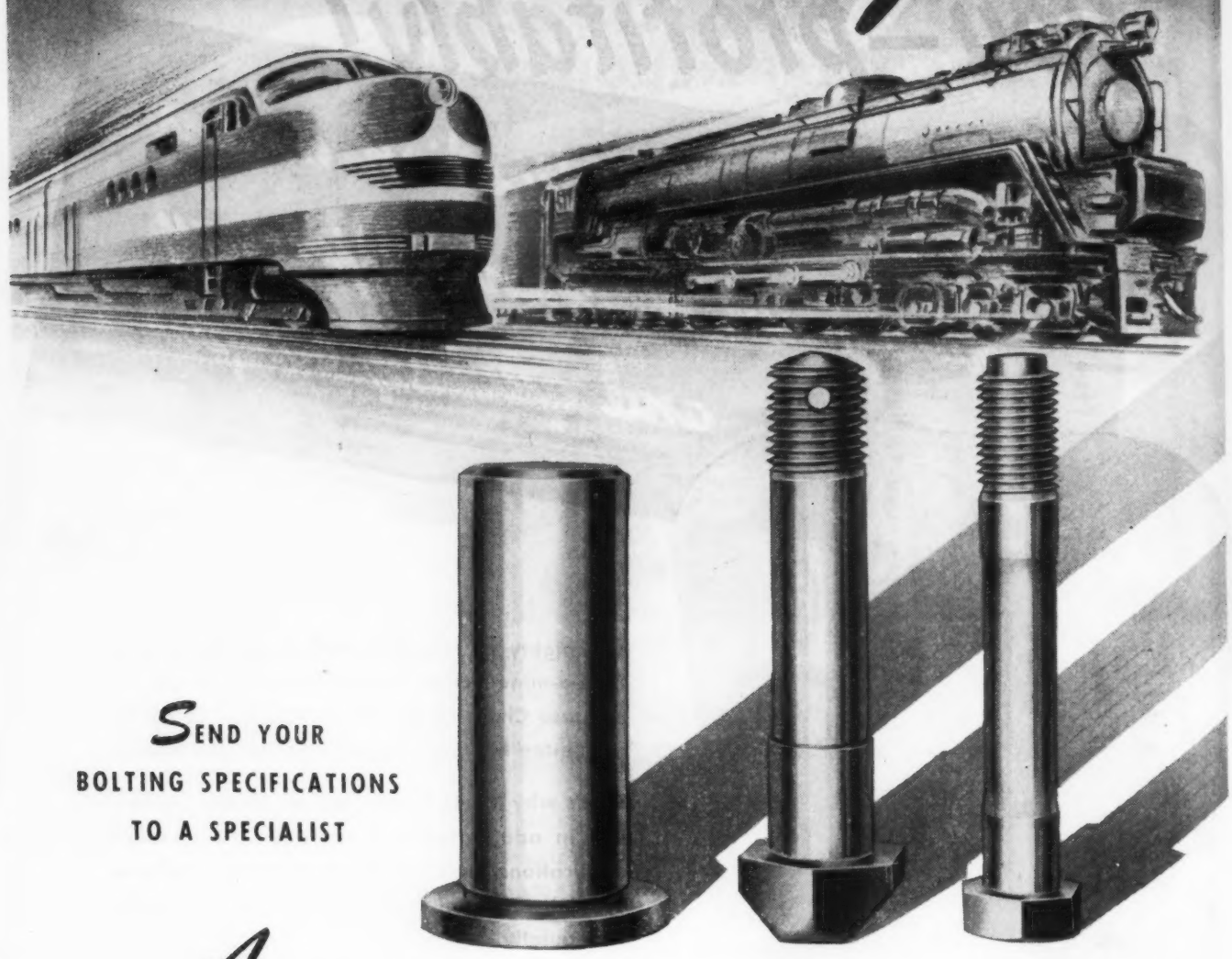
MORSE Roller and Silent CHAINS

MORSE CHAIN COMPANY • ITHACA, N.Y. • DETROIT 8, MICH. • A BORG-WARNER INDUSTRY

Erie Bolting



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TO A SPECIALIST

AS A SPECIALIST in the manufacture of distinctive bolting, ERIE has manufactured thousands of various bolts, studs and pins. Typical of these are the three pieces shown, which are used in the building of steam and Diesel locomotives.

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When high quality fasteners are required, together with assurance of lasting economy and top performance, it will pay you to call on ERIE Your inquiries will receive our best attention.

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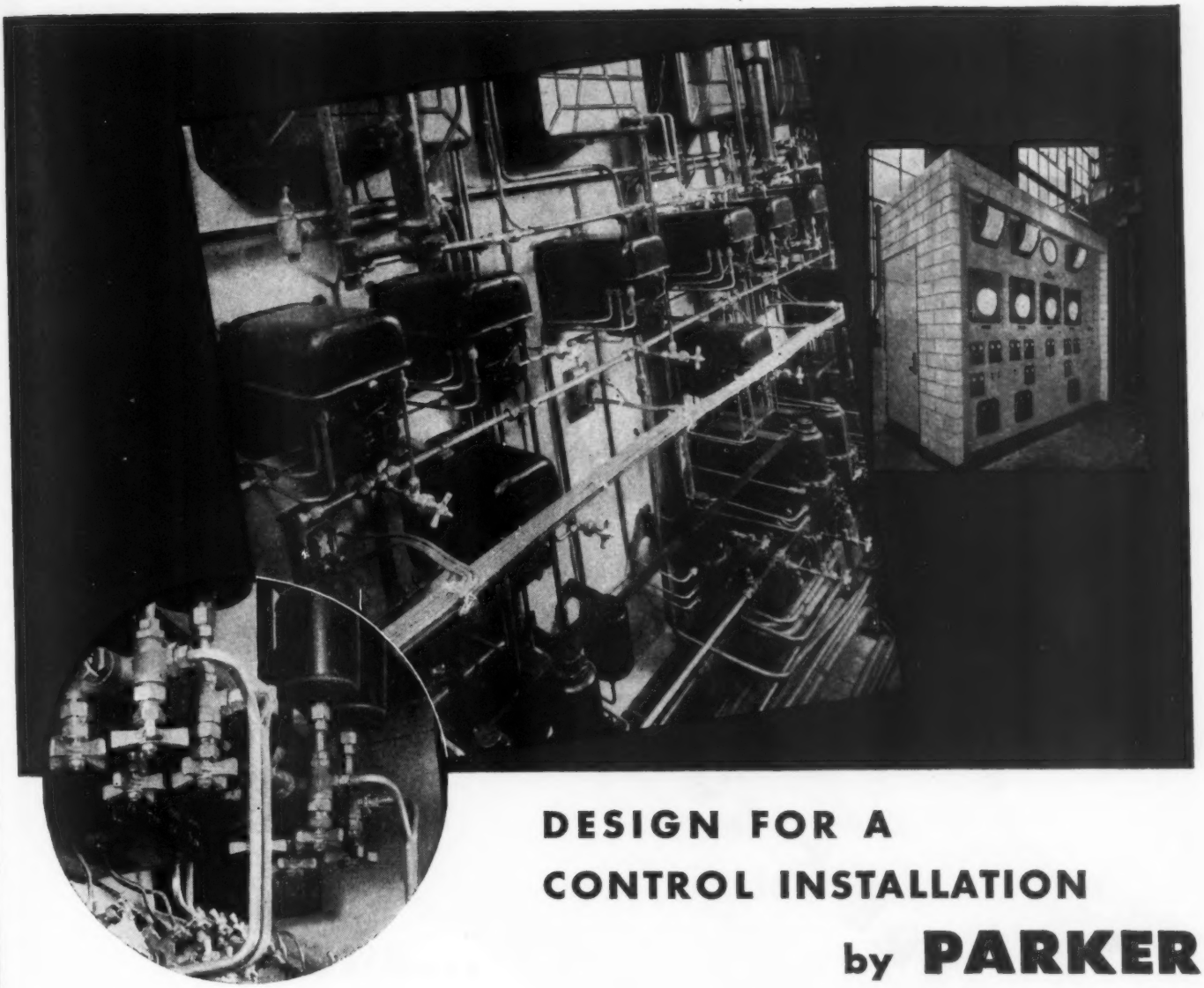

DESIGN FOR A CONTROL INSTALLATION by PARKER

This boiler control installation is an example of Parker Fluid Power Engineering.

To guarantee the prompt and accurate registering action of the many meters and control devices that make up this system requires a precisely engineered tubing layout that will allow ease of application in a compact area . . . provide easy removal of instruments and control apparatus for maintenance or replacement . . . guarantee smooth flow and low pressure drop through the elimination of sharp turns and internal obstructions . . . reduce the number of joints and connections. It calls for the designing "know-how" that will insure a simplified, neat-looking, readily-serviced, trouble-free installation.

Parker Fluid Power Products are vital in this system. Specially designed to do the job, they have been proved by 20 years experience, and are serving in thousands of industrial piping installations.

If you are using . . . or plan to use . . . fittings, valves or fabricated tubing—on presses, machine tools, earth-moving equipment, motor vehicles, aircraft, refrigeration and process applications, look to Parker for effective installations and dependable products.

A Parker engineer will be glad to work with you, and three modern Parker plants have the facilities you need. The Parker Appliance Company, 17325 Euclid Avenue, Cleveland 12, Ohio.

PARKER

FLUID POWER ENGINEERING

UNBRAKO
Reg. U. S. Pat. Off.
HERE'S THE ORIGINAL
...AND MOST WIDELY USED
Socket Head Cap Screw
Reasons for the "Unbrako's" rise to prominence and continued popularity over a period of many years are: exceptional strength and accuracy; uniformity; fine quality of steel used; neat appearance AND the knurled head, perhaps the "Unbrako's" greatest advantage because of its value as a production time-and-money-saver. Mechanics rightly call the "Unbrako" the "handiest screw in the shop" because they can turn the knurled head farther and faster by hand before a wrench is needed.
SIZES: No. 4 to 1½" DIAMETER.
WRITE FOR THE "UNBRAKO" CATALOG.
REG. U. S. PAT. OFF.
KNURLING of Socket Screws originated with "UNBRAKO" years ago.
UNBRAKO
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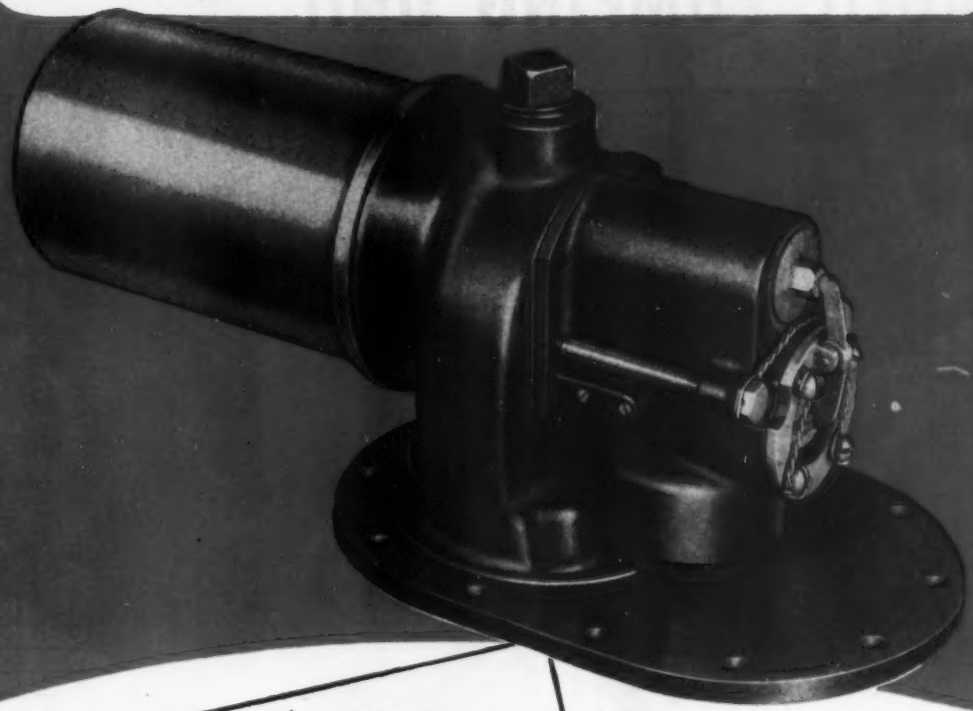
JENKINTOWN, PENNA., BOX 548 BRANCHES: BOSTON · DETROIT · INDIANAPOLIS · CHICAGO · ST. LOUIS · SAN FRANCISCO
Over 40 Years in Business

Steps up Horsepower



The New **ROMEC**

FULLY *Submerged* WATER INJECTION PUMP

Here is a fully submerged pump that gives aircraft engines an abundance of extra horsepower when needed in an emergency. No robber of valuable room, this pump requires less than 1½" space on outside of tank for mounting purposes. It supplies water or water-alcohol mixtures that are vaporized in the combustion chamber. The corrosion problem has been solved with special internal insulation as well as external contact insulation. Engineered for wide temperature ranges with heat being more quickly dissipated. This dissipated heat, together with agitation caused by relief valve discharging directly into tank, also greatly reduces freezing hazard. This new Romec Fully Submerged Water Injection Pump is also available with supercharger connections. Write for details. Illustrated is RD 8500A with supercharger connection.

Romec

PUMP COMPANY

100 ABBE ROAD • ELYRIA, OHIO, U.S.A.

USE THIS COMPACT Sundstrand HYDRAULIC PUMPING UNIT

Sundstrand WX pumping unit made in seven sizes. For actuating indexing devices, clamping mechanisms, brakes, etc.

A large volume of oil for rapid traverse of the moving member and, a smaller volume at high pressure for the actual work, are *both* obtained from this pumping unit.

The Sundstrand WX pumping unit performs this double duty with a large capacity pump, which brings the moving member into position, then dumps its oil under slight pressure. A smaller pump maintains the high pressure required for the work. No large volumes of oil are wasted through by-passing. Power consumption is cut. Further, since pumps and valves are assembled as a single unit, compactness, ease of installation and piping simplicity are obtained.

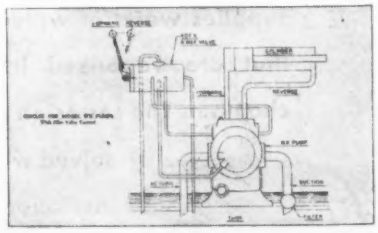
IF YOU ARE DESIGNING clamping fixtures, arbor presses, indexing devices, hydraulic brakes, hydraulic clutches or other equipment requiring both low and high pressures it will pay you to investigate the Sundstrand WX pumping unit.

4 Basic Advantages

1. *Less Heating of Oil*—output of small pump only is by-passed at high pressure.
2. *Less Power Used* — only low capacity pump is operated at high pressure.
3. *Quick Action* — from large volume of oil delivered by rapid traverse pump.
4. *Easily Installed* — only two lead pipes required to cylinder or other actuated member.

A TYPICAL APPLICATION

Here is an example of the use of the WX pumping unit in a simple circuit. Note the simplicity of piping due to compact design of pumps and valves.



How to Use These Units in Your Designs

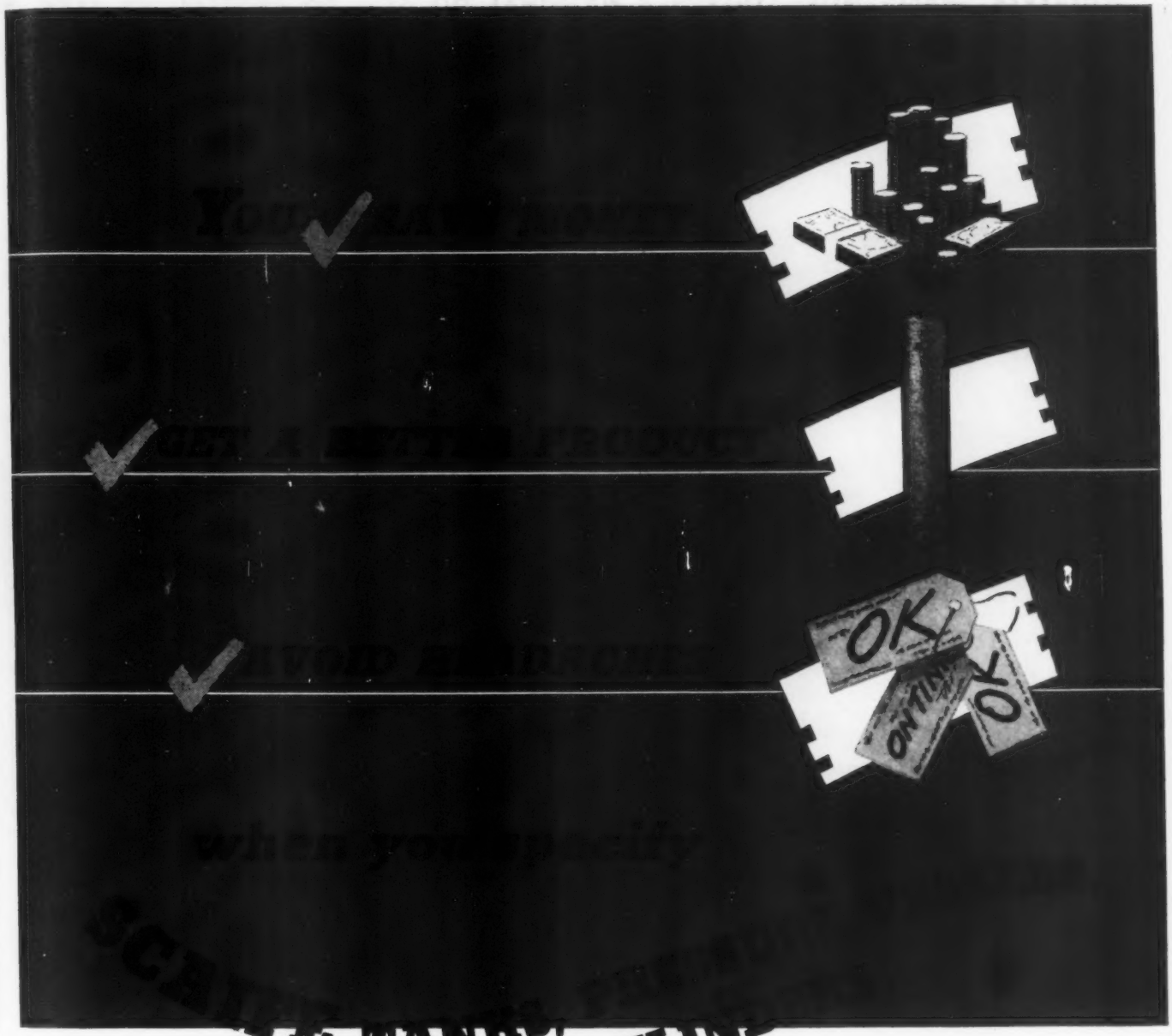
Additional design information on this unit is contained in this four page bulletin. Write for your copy today. Ask for bulletin WX-2.

SUNDSTRAND MACHINE TOOL CO. · ROCKFORD, ILLINOIS, U.S.A.

SUNDSTRAND PUMP DIVISION

2556 ELEVENTH STREET • ROCKFORD, ILLINOIS

FUEL UNITS • HYDRAULIC PUMPS • TRANSMISSIONS • FLUID MOTORS • VALVES and CONTROLS



★ **Taking the "tough" specifications in stride—**

★ **Setting the pace in dependability for more than a century and a quarter—**

★ **Providing *advanced engineering* through all these years—**

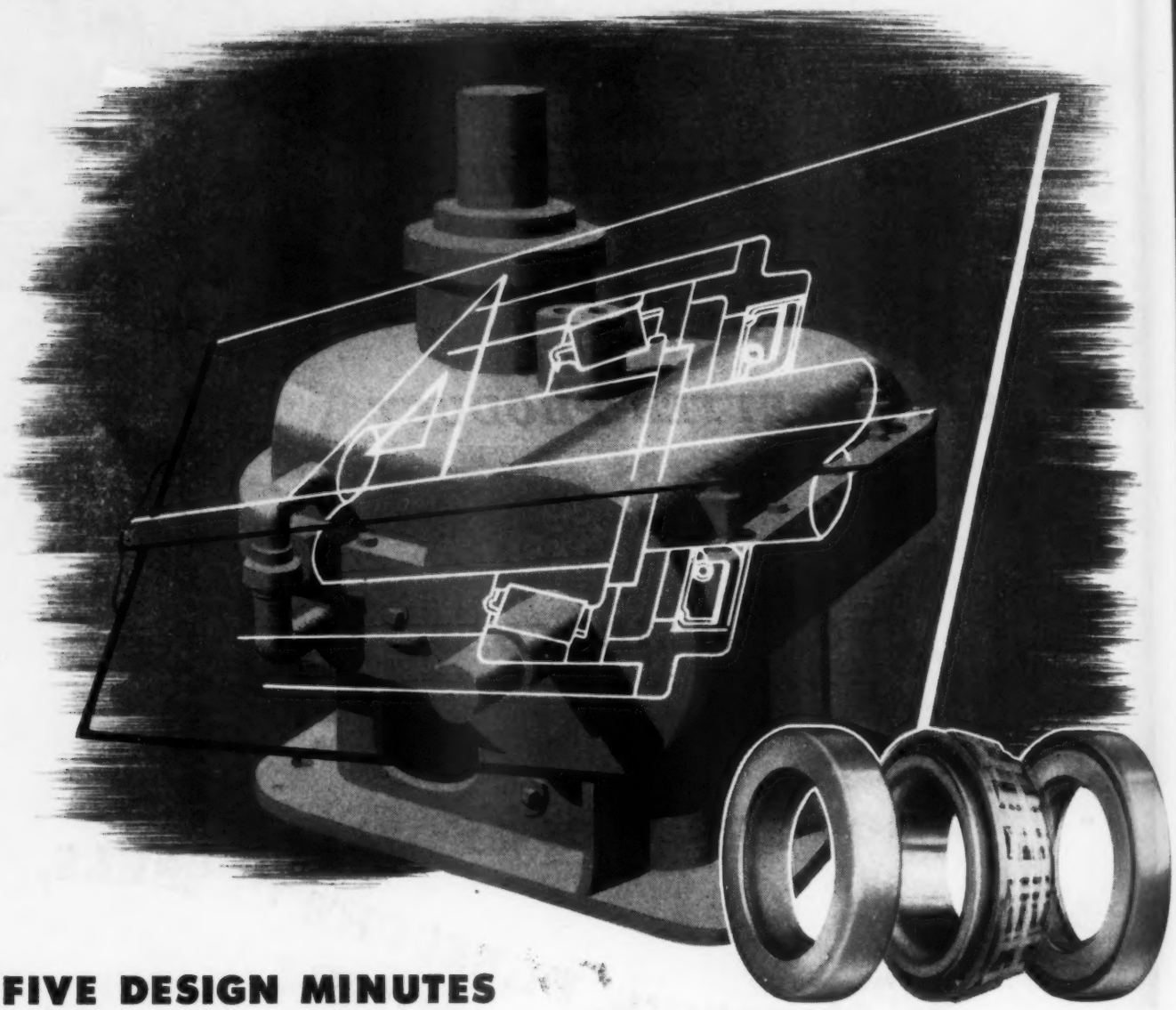
★ **Pioneering important developments in materials, methods and modern equipment—**

—These qualities have made "Scaife" a top-ranking name, wherever tanks for air, water and gases, pressure vessels and cylinders are used.

For greatest satisfaction in the future, let Scaife engineers cooperate with you *now*.

Scaife Company

WHEREVER SHAFTS MOVE, THERE'S A NATIONAL OIL SEAL TO PROTECT ITS BEARINGS



FIVE DESIGN MINUTES MAY ADD FIVE PERFORMANCE YEARS

The time required to "design-in" proper bearing protection is nothing compared to the extra years of efficient trouble-free performance the machine will deliver. Like the bearings themselves, bearing protecting units have had to become more efficient and dependable as the speed of machines increased. National Oil and Fluid Seals are the result of a quarter century of specialization in solving oil sealing problems. Their value and efficiency have been proved in the most gruelling mechanical tests . . . the machines of war . . . where they are standard equipment.

National Oil Seals mean long-lasting efficiency, both in retaining lubricants in the bearings and excluding abrasive dirt. These units mean economical operation with minimum replacements even under severe operating conditions. Stock numbers stand speeds up to 2000 f.p.m.; temperatures well over 200°F. Special designs can be developed for special problems.

They are compact and thus eliminate need for extra large bearing housing; allow greatest latitude to the designer. They are precision made for quick press-fit installation. The assistance of National Oil Seal Engineers, backed by a quarter century of experience, is at your service, whether for design assistance or for the development of special sealing units.

NATIONAL MOTOR BEARING CO., INC.
GENERAL OFFICES: REDWOOD CITY, CALIFORNIA
PLANTS: REDWOOD CITY, CALIF.—VAN WERT, OHIO
LOS ANGELES, CALIF. (ARROWHEAD RUBBER CO.)

CALL IN A NATIONAL ENGINEER FOR RECOMMENDATIONS
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NATIONAL
OIL AND FLUID **SEALS**

Read how
BRAZING News
No. 31
LOW TEMPERA
Issued by Handy & Harman
St., New York 7, N.Y.
EASY-FLO TOOK THE BRAKES OFF PRODUCTION ON THIS AIRPLANE BRAKE ASSEMBLY
This is the "before and after" story of an airplane hydraulic brake cylinder. Read it and you will understand why scores of products, formerly cast, forged or machined from the solid, are now produced by EASY-FLO Brazed Construction, and why more and more new products are being designed from scratch to take full advantage of this accepted, time-tested method of cutting fabrication costs.

The complete operation of fabricating the Brake Cylinder is illustrated and described in this bulletin. The entire job is done by girl operators —which makes clear that, in addition to its other decisive advantages, EASY FLO BRAZED CONSTRUCTION is a simple production proposition. It's a proposition you'll want to know about and consider for present as well as future products.

Write for your copy of the Bulletin today

Ask for Low Temperature Brazing News No. 31

•

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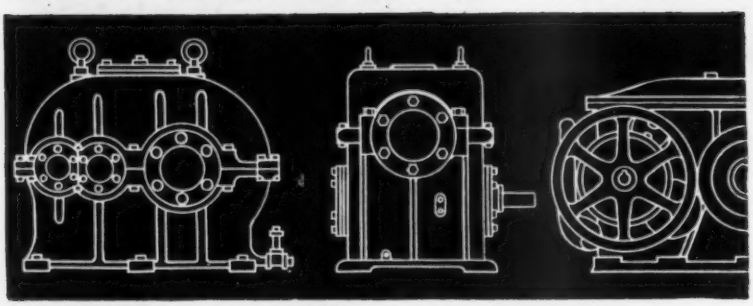
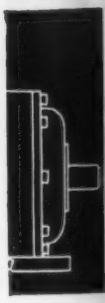
HANDY & HARMAN

Brad Foote Gears



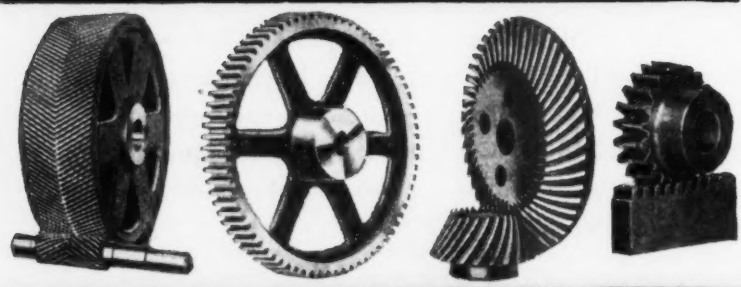


SPEED REDUCERS

There is a Brad Foote Speed Reducer to fit every need. Made in all sizes—all horse powers—any ratio—all tooth forms.

SPECIAL GEARS

Brad Foote special precision cut gears are fitted for installation on the most exacting jobs. Made in all sizes from any practical material in all tooth forms—Herringbone — Helical — Bevel — Worm and Gear—Spiral Bevel and Spur.



Over a generation of experience goes into every Brad Foote product and extensive plant capacity and shop equipment assure prompt delivery of great quantities of smooth running quality gears.

Write us about your geared reduction problem — full information will be promptly sent you.

BRAD FOOTE GEAR WORKS

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To Produce Drop Forgings Up to 2500 Pounds

New techniques plus experience and specialized manufacturing facilities produce unusual-shaped drop forgings up to 2500 pounds. Greater strength and economy in vital parts by use of drop forgings provide engineers wider latitude in product design.

Ladish engineers are available for consultation on your products.

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CUDAHY • WISCONSIN

MILWAUKEE SUBURB

"THEY PUT THE LIFT IN LIFT TRUCKS"

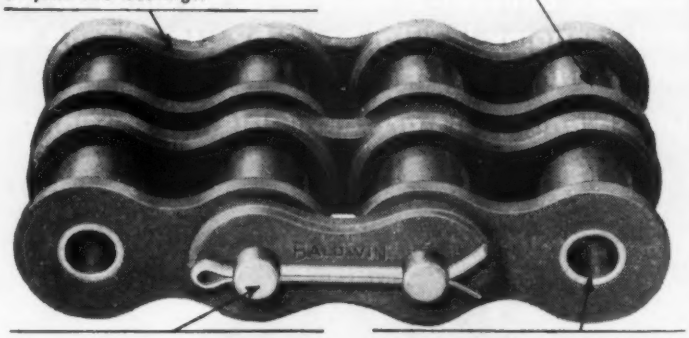
① BALDWIN-REX ROLLER CHAIN BELTS have the positive power . . . shock absorbing qualities—high-strength to low-weight ratio to give you ideal design conditions for compact lifting mechanisms.

② FOR EXAMPLE: The Baldwin-Rex roller chains driving the elevator keep the loads going up and down smoothly and positively. They do not waste power. They do not jerk and shift or tip a heavy load. They absorb shocks which might be damaging. And they have the strength to handle the heaviest loads.

③ IF YOU have a problem involving the transmission of power, or timing of operations, investigate Baldwin-Rex roller chain belts. They operate efficiently on both long and short centers. They keep speed ratios constant and accurately time operations to the split second. Easy to install, compact, clean and quiet in operation, Baldwin-Rex roller chain belts are preferred by machine designers.

Steel side plates, heat-treated for strength and toughness, blanked, pierced and broached to insure uniformity of pitch and press fits on pins and bushings.

Alloy steel roller heat-treated for extreme toughness and resistance to wear, then ground to size.



Alloy steel pin, case hardened, ground for accuracy, superior bearing surface. Shorter pitch chains furnished with riveted construction.

Alloy, case hardened steel bushing ground for accuracy and press fits in side bars.

For catalogs on Baldwin-Rex roller chain belts or competent information on your specific drive, timing or conveying problems, write **BALDWIN-DUCKWORTH** *Division of* **CHAIN BELT COMPANY,** *321 Plainfield Street, Springfield 2, Mass.*

BALDWIN-REX ROLLER CHAIN BELTS

Baldwin-Duckworth Division, Springfield 2, Massachusetts • Rex Chain Belt and Transmission Division, Rex Conveyor and Process Equipment Division, Milwaukee 4, Wisconsin

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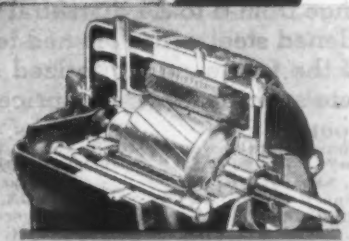
For New Designs in Unit Heaters

LOOKING for an AC motor of a 25th horsepower or less that you won't have to worry about? ☆ Do you want a product that's gone through years of engineering especially for the heating and ventilating industry? ☆ Are you after quiet operation, extra long life, sturdy construction and simplified modern design? ☆ Must it be neat and compact and readily adaptable? ☆ Well, you're probably looking for a power unit just like one of the fine new Redmond Type "T" Micromotors. Drop us a line today and let us tell you all about them.



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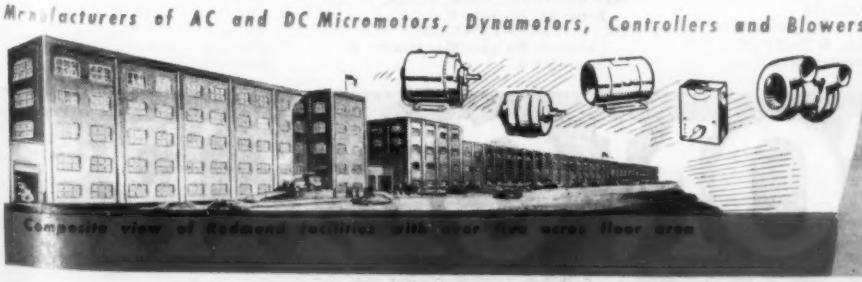
Flush-Weld Rotors permit tailor-made performance. **Pressure-Locked Rubber Mountings** have no bolts or nuts to work loose. **Air-Stream Cooling** allows small size. **Direct Feed Lubrication** and **Super Capacity Reservoirs** assure long life. **Spring Tension Centered Bearings** retain accurate alignment. **Micro-Tolerances** reduce vibration. **Impregnated Windings** resist oil and moisture. **New Machining Processes** assure uniform heat dissipation.

A. G. Redmond Company

OWOSSO, MICHIGAN, U.S.A.

Manufacturers of AC and DC Micromotors, Dynamotors, Controllers and Blowers



Composite view of Redmond facilities with over five acres floor area

REDMOND KNOWS MOTORS

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REDMOND

SPIRAL GEARS

IN STOCK READY FOR YOUR IMMEDIATE USE, that's the situation with many sizes of Boston Gear Standard spiral gears. Boston Gear Standard sizes are cut right and left hand at an angle of 45 degrees and range from 6 to 24 diametral pitch and from 1/3" to 6" pitch diameter. Further, all sizes are furnished in hardened steel with polished teeth and in addition the two largest groups are supplied also in bronze. Any of the following authorized distributors and direct company branches will be pleased to give you complete specifications and prices of these Boston Gear Standard spiral gears:

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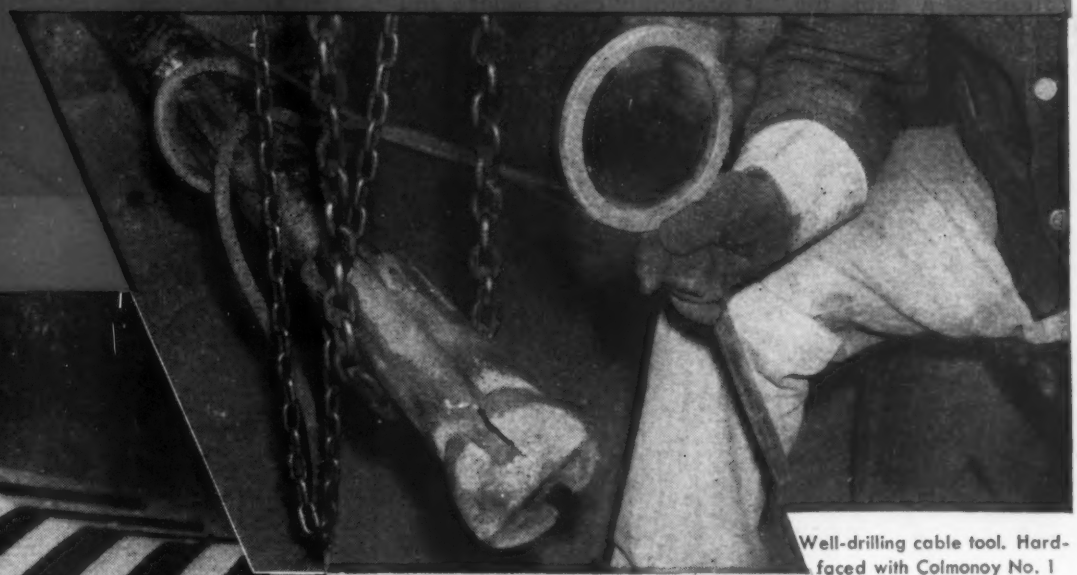
BOSTON GEARS

COLMONOY NO. 1

Hard Facing Electrode



Well-drilling cable tool. Hard-faced with Colmonoy No. 1

Dipper teeth. Hard-faced with Colmonoy No. 1

ROCKWELL C 58-62

● Colmonoy No. 1 is both tough and shock resistant. It won't chip or break off when subjected to such terrific punishment as it gets on construction or digging equipment. It is a flux-coated, general purpose electrode particularly adaptable for building up relatively large sections of thick, hard-facing overlays.

It is at its maximum hardness when deposited, and is highly recommended for building up hot guides, tractor parts, digger teeth, shovel teeth, well-drilling cable tools and the many machine and industrial applications subject to severe, sudden shock and abrasion.

Colmonoy No. 1 is but one item in a complete line of alloys for every hard-facing need.

Write for Catalog—

COLMONOY NO. 1

Ferrous Hard-Facing Alloy. Specific gravity 7.70. Melting point, 2400° F. Approximate composition %: Cr. 7-11. B. 1-2. Si. 2-4. Fe. Bal. Very high wear and shock resistance. Non machinable.

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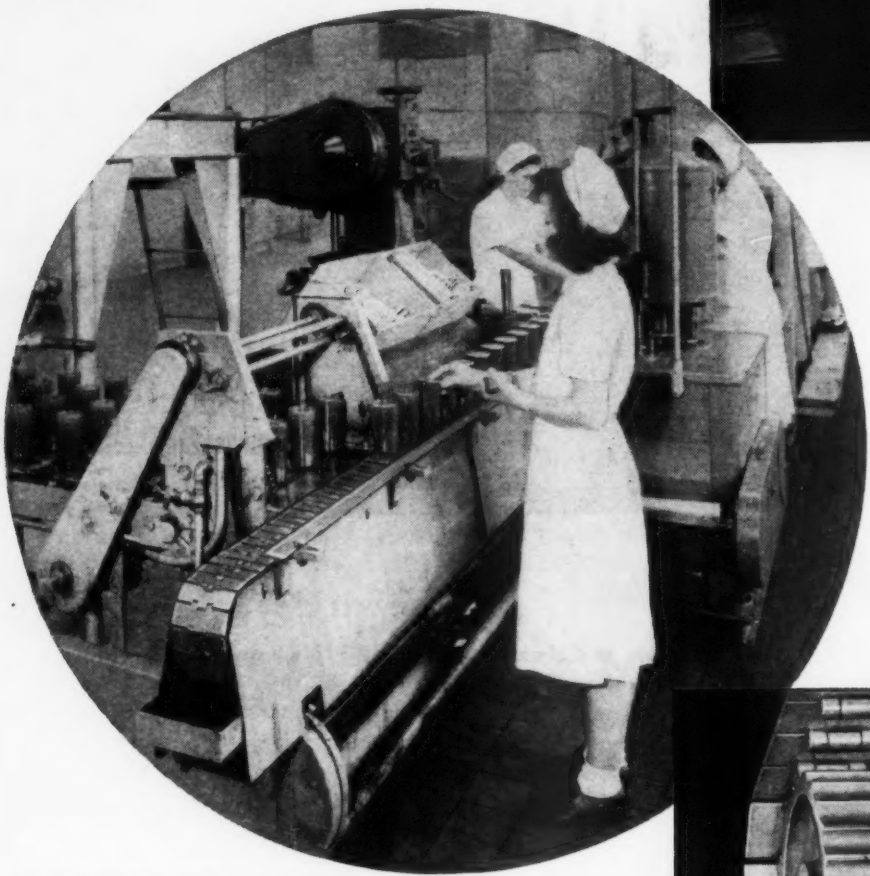
WALL-COLMONOY CORP.

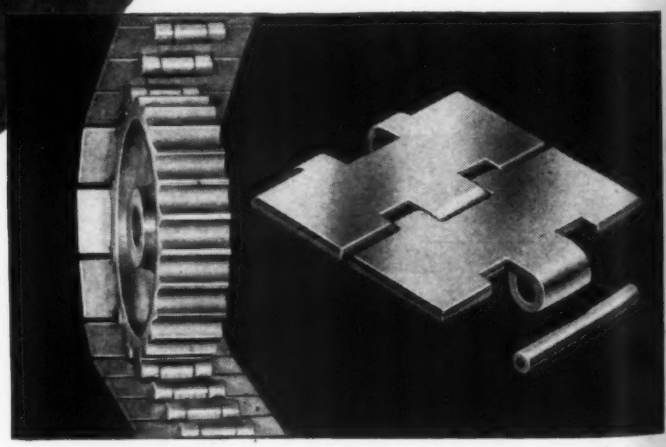
720 Fisher Bldg., Detroit 2, Michigan

YOU WON'T "SPILL THE WORKS"

① IF YOU'RE DESIGNING a bottling labeling, sealing or capping machine, you'll need a conveyor chain that won't "spill the works." Rex Table Top fits that need to a "T." With a smooth surface that's as steady as a "table top," it practically ends spillage and breakage.



② THIS BOTTLING PLANT uses Table Top to carry jars of preserves from the filling to the capping machines. The simplicity of Table Top's design . . . just a one-piece platform link with a simple pin connection . . . assures greater steadiness. Table Top stays cleaner. There are no pockets to catch and hold dirt. It never catches or trips containers at transfer points for the perfectly flat, beveled-edged links slide freely under blocked containers.



③ TABLE TOP WEARS LONGER: In the diagram at the right, note how the entire length of the Table Top joint is engaged by the sprocket tooth for smooth action, greater bearing area and long life. The Table Top link absorbs the pulling load when flexing over the sprocket. The pin is relieved of all load. Table Top just *has* to last longer.

* * *

Rex Table Top is the answer to any problem involving the conveying of bottles, jars and cans. The Rex Man will help you with your chain belt application problems. For complete information on Rex Table Top, write for your copy of Bulletin No. 464. Address Chain Belt Company, 1715 West Bruce Street, Milwaukee 4, Wisconsin.

REX CHAIN BELTS

Manufactured in every available type for positive transmission of power, timing of operations and conveying of materials

CHAIN BELT COMPANY OF MILWAUKEE

Rex Chain Belt and Transmission Division, Rex Conveyor and Process Equipment Division, Milwaukee 4, Wisconsin • Baldwin-Duckworth Division, Springfield 2, Massachusetts

IT TAKES MODERN EQUIPMENT

to produce Tomorrow's

STREAMLINED PRODUCTS

HANSEN *Push-tite* COUPLINGS

Tomorrow's production is going to be the answer as to how you can meet keen competition in the highly competitive market of the coming postwar days. • Competition cannot be met without peak production and peak production cannot be attained without modern equipment, one fits into the other. • One way to reach peak production is by short cuts and that, in turn, means Hansen Industrial Couplings, which are easier to operate, faster, save many steps, much time and a considerable volume of air. • Hansen Couplings are easy to operate, merely insert plug into socket, it is connected, locked and air is automatically turned on. To disconnect, slide sleeve back with thumb, plug is ejected and air is automatically turned off. • *There's a Hansen Coupling made for air, oil, grease, gasoline, oxygen and acetylene. Send in for free industrial catalog.*

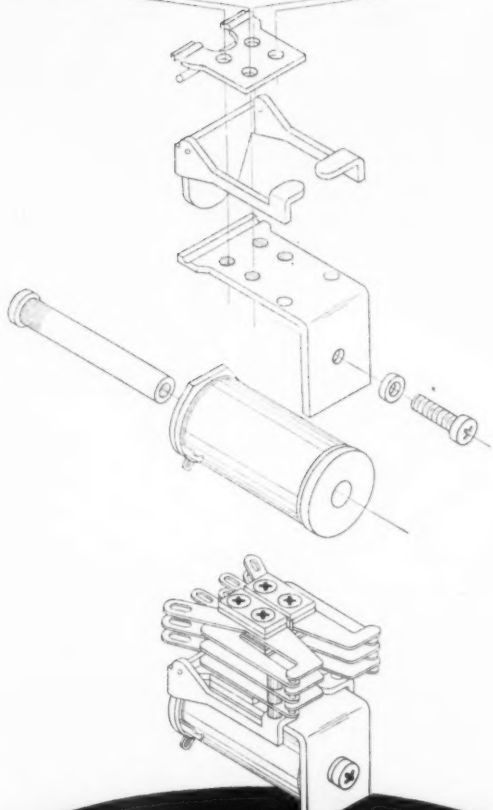
THE HANSEN MFG. COMPANY

1786 EAST 27th STREET • CLEVELAND 14, OHIO

PRECISION-BUILT RELAYS

"*Extra*-Ordinary" ENGINEERING

Cook relays are designed and engineered in modern laboratories by engineers who have the finest production and testing equipment at their disposal. Fine equipment in itself, however, is not always the basis of good engineering. The men in Cook laboratories must also qualify by possessing sound, practical and theoretical engineering principles. These principles are not only prevalent in the men in our laboratories, but are also characteristics of our entire staff of field engineers. These are the men located throughout the principal cities in the United States and Canada, who are at your disposal when any relay problems present themselves.



"*Extra*-Ordinary" CRAFTSMANSHIP

The stamp of craftsmanship in the manufacture of Cook relays starts in the drafting room. It is there that careful drawings, such as the accompanying illustration, are prepared. From this drawing through the specification of the best and highest grades of materials, precision manufacture of all parts, the careful assembly, and the rigid testing of the completed relay, every step along the way is an operation in which Cook craftsmen take pride.

The relay illustrated is one of the new "400" series of small Cook relays. It is 1-7/16" L. by 1-5/16" W. by 1-7/16" H., operates normal coil voltage of 28 volts. Will operate at 14 volts and maintain proper contact pressure over 30 grams. Operating time less than 10 milliseconds.

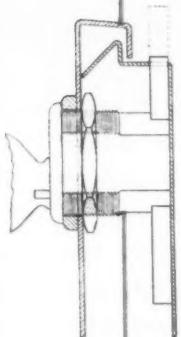
2700 SOUTHPORT AVENUE

COOK ELECTRIC Company

CHICAGO 14, ILLINOIS

In locking devices . . .

KNOW-HOW, SERVICE, QUALITY in one "Package"!



The above lock shown as applied to a modern metal desk. Application is simple, fast and cost reducing.

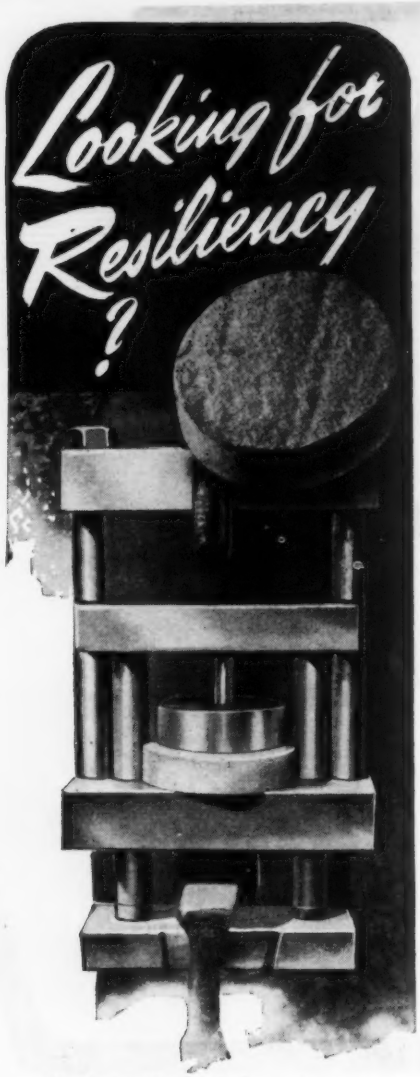
When a locking device job descends on you marked "Rush" here's how to get quick, QUALITY help! If a stock design is to be specified . . . a copy of our concise "Industrial Catalog" as near as your files can work wonders in saving time and effort. If you haven't a copy – write for one today.

When you're designing new "from the bottom up" send us a blueprint or ask a Corbin Lock engineer to call. His intimate knowledge of thousands of quality locking devices of every type and description will dovetail perfectly with your own requirements.

For 62 years we have worked with design engineers to mutual benefit. In the natural "give and take" of this experience we have both learned a great deal and contributed much that can never be measured in mere dollars and cents – but is yours for just the asking!

CORBIN

CORBIN CABINET LOCK CO.
DIVISION OF AMERICAN HARDWARE CORPORATION
NEW BRITAIN, CONNECTICUT
"Safety first....and last....when Corbinlocked"



IN EXTENSIVE laboratory tests, the compression of certain (½-inch thick) Booth felt samples under load of 150 lbs. per sq. in. resulted (after load removal) in "permanent" loss in thickness of only .005 inch!

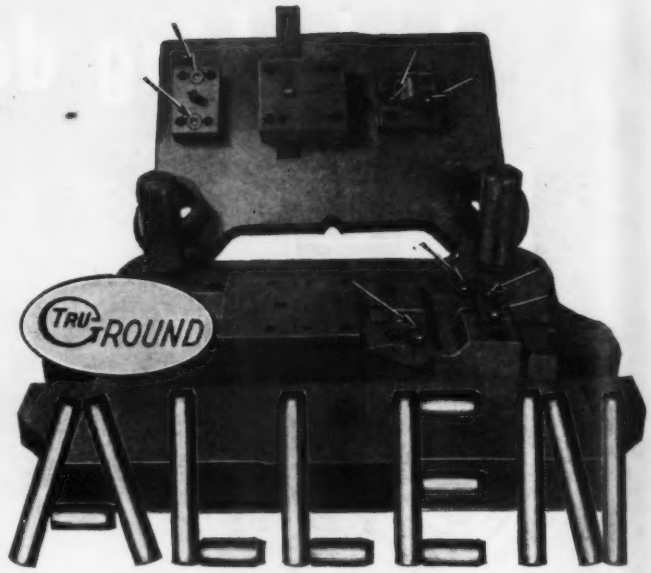
Yes, Booth "prescription" felt manufacture can be controlled to give you the amount of resiliency, or almost any other quality, desired in your material.

THE BOOTH FELT COMPANY
475 19th Street Brooklyn, N. Y.
736 Sherman Street Chicago, Ill.

2071

Booth
TRADE MARK

PRECISION CUT FELT PARTS



Dowel Pins

They serve as locating pins for the diemaker's work — and then go on to general duty as pins and pivots in various machine assemblies.

By their accuracy and strength they *retain* precision standards in tool and die and machine assemblies under punishing stresses.

They are ground to a limit of .0002″ over basic size, with an allowable tolerance of plus or minus .0001″. Surfaces are finely polished; subsequently treated with a rust-preventive.

Metallurgically in a class with ALLEN Hex-socket Screws: — made of the same special-analysis *ALLENOY* steel, heat-treated to an extremely hard surface, with a core of the right toughness to prevent "mushrooming" when driven into a tight hole... Tensile strength, 240,000 to 250,000 lbs. per sq. inch... Typically the Allen high safety-factor in HOLDING-POWER.

Ask your local ALLEN Distributor for samples and dimensional data . . . the same Distributor who serves you dependably with Allen Hex-socket Screws and other "life-lines" of essential supplies.

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THE ALLEN MANUFACTURING COMPANY
HARTFORD 1, . . CONNECTICUT, U. S. A.

Not everybody

FEW manufacturers possess the versatile production facilities of The Standard Products Company.

Standard is prepared to develop and plan for industry, parts of molded rubber, steel stampings, plastics, in almost any shape or form.

The services of The Standard Products Company Research Laboratory and Engineering Departments are at your disposal. Let us have the necessary data and our engineers will submit designs and proposal.

The Standard Products Company is the world's largest manufacturer of glass run window channel and contour weather strip. Production and replacement channel for passenger cars, truck cabs, busses, motor boats, airplane cabins and streamlined trains is now available for delivery.

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Main Offices and Research Laboratory

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60,000 lbs.-

of Aluminum Ingots per day Required to Meet the Demand for ACME BETTER CASTINGS

THIS pile of aluminum ingots will be just a bite for the hungry furnaces in the Acme foundry. For in becoming one of the five largest aluminum foundries in the United States, Acme has stepped foundry capacity up to nearly 60,000 pounds of aluminum per day.

Both sand and permanent mold aluminum castings are made in accordance with advanced foundry techniques, the permanent mold process being particularly notable for insuring close tolerances, uniformity, and high tensile strength.

Acme progress is important to you as well as to us. For it is based on producing castings which meet the most advanced requirements of today's metalworking industry for permanent mold aluminum alloy castings.

For castings to speed your production and to cut your costs, submit your requirements to Acme.

NEW ACME BOOK TELLS THE STORY — Send for new 44-page, fully illustrated book, showing how Acme is organized and equipped to supply your castings needs and to render complete service to the metalworking industry.

ACME *Aluminum Alloys, Inc.*
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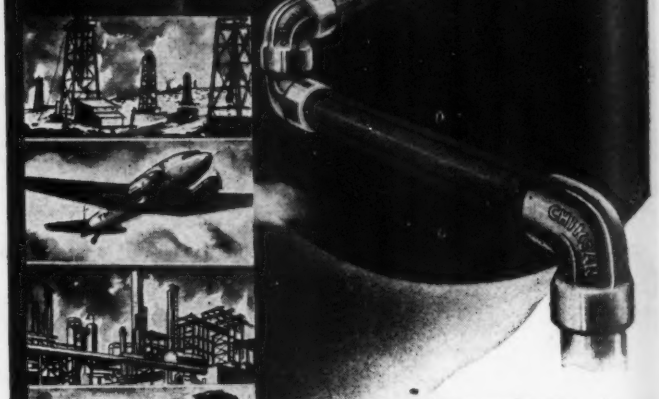
PATTERNS • TOOLS • ALUMINUM CASTINGS • ENGINEERING

Covering a World of Uses with

CHIKSAN



On land and sea and in the air . . . wherever liquid, air or vapor lines must swing or turn to provide for movement of equipment, vibration or easy handling . . . CHIKSAN *Ball-Bearing* Swivels render safe, dependable service.

CHIKSAN FORMULA FOR PERFECT FLEXIBILITY

$$BB_2 + EP = \frac{LT}{P/V}$$

CHIKSAN *Ball-Bearing* Swivels swing or rotate with minimum torque because all turning takes place on double rows of ball bearings. Self-adjusting pack-off is equally effective for both pressure and vacuum. There is nothing to tighten or adjust.

Over 500 different Types, Styles and Sizes assure the correct Swivel for every purpose: For temperatures to 700° F. in High Temperature Joints and for pressures to 3,000 lbs. in High Pressure Styles. Sizes range from ⅜" to 12" . . . or larger to order.

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The Closest Approach to Perfection

GEARGRIND Machines give you both production and the tolerances required by modern engineering. Low overall production costs reflect the accuracy that practically eliminates rejects and provides the fine finish that makes many operations unnecessary.

We manufacture a complete line of "GEARGRIND" Machines for the Formed Wheel Grinding of external and internal gears, internal involute splines, straight splines, racks and serrations, as well as special machines for special grinding operations.

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Covers all GEARGRIND Machines and Contract Grinding Service.

GEARGRIND TYPE GG-24-48
Handles external gears up to 24" diameter.
Takes up to 48" between centers.
Complete specifications in catalog.

ARMY E NAVY

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Manufacturers of RZEPPA Constant Velocity Universal Joints

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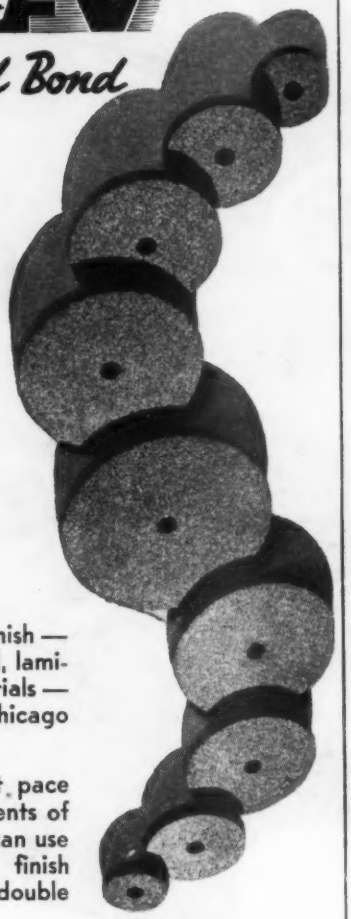
with Chicago FV

the Pedigreed Bond



It's the new bond that gives the ultra smooth finishes you get with Chicago Grinding Wheels—

Precision finishes undreamed of before—

Finishes so accurate that you can measure them in micro inches with a Surface Analyzer.

PERFECT FINISH INSURANCE

Whatever you have to finish — metals, alloys, plastics, wood, laminates or composition materials — you can do it better with Chicago Wheels.

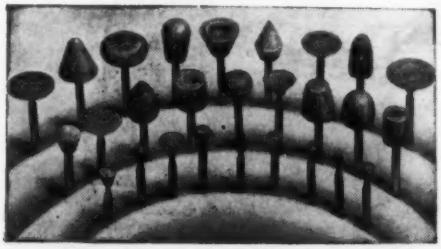
Chicago Wheels have kept pace with the precision requirements of our war industries, and you can use them with confidence to finish civilian goods better in double quick time.

CHICAGO GRINDING WHEELS

A wide range of grains and grades and—for the duration—sizes up to 3" in diameter.

TRY ONE FREE—We'll send without charge a Mounted Wheel or an FV Bond Grinding Wheel. Tell us size you'd like.

CHICAGO MOUNTED WHEELS



The first made and the finest today. In a selection of bonds, abrasives and shapes to handle each job more efficiently.

Write for Catalog listing all Chicago products and showing comparative photographs of finishes with different kinds of Wheels

CHICAGO WHEEL & MFG. COMPANY

Headquarters for Mounted Wheels and Small Grinding Wheels

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☐ Mounted Wheels. ☐ Grinding Wheels.

☐ Send Test Wheel. Size.....

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SETS THE STANDARD

The "Quality" demanded by Curtis Universal Joint "Standards" gives every user of Curtis Joints a product that meets and surpasses rigid and strenuous wartime needs.

Each part shown has special features — successfully proven in hundreds of applications by airplane and machine tool industries.

Twenty years of experience selecting the right steels, special heat treatments developed by Curtis, careful machining to close tolerances, finished ground surfaces all accurately fitted to give positive, free articulation, are incorporated into each part.

Figs. 1 & 2 FORKS — heat treated to secure maximum toughness and strength, inside ear surfaces accurately ground for close, smooth working operation, pin holes broached and honed for perfect alignment, the O. D. cylindrically ground for concentricity.

Fig. 3 CENTER BLOCK — holes intersecting accurately in the center, with the faces parallel, hardened and precision ground for long wear, with recess for the Telltale Lock ring.

Figs. 4 & 5 PINS — hardened and centerless ground to close tolerances reduce radial play.

Fig. 6 OILER — Curtis pioneered proper and essential lubrication, and made it easy by furnishing patented oilers in the large pin.

Fig. 7 "TELLTALE LOCK RING" — patented by Curtis — snaps into small pin groove and fits recess of center block. This insures firm, positive lock-up of entire assembly — makes disassembly and reassembly quick and easy, and the "Telltale" end shows at a glance that the ring is in proper locking position.

Curtis Engineers can help solve your universal joint problems. Our experience and knowledge are yours for the asking.

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• When you buy springs, remember this. Here at Accurate, we've crowded 12 ordinary years' experience into the last four. We've produced millions of springs of various kinds, sizes, shapes and materials. In doing this . . . we've had to use our fullest ingenuity . . . searching for newer, faster ways of doing everyday jobs . . . developing special machines and unique methods of turning out unusual springs and wireforms . . . often helping our customers with ideas that have meant a lot to them . . . in time . . . in money.

In your postwar planning . . . remember that Accurate's wealth of spring experience is . . . *at your service.*

SPRINGS
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STAMPINGS

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Send for your copy of the new Accurate Spring Hand-book. It's full of data and formulae which you will find useful. No obligation, of course.

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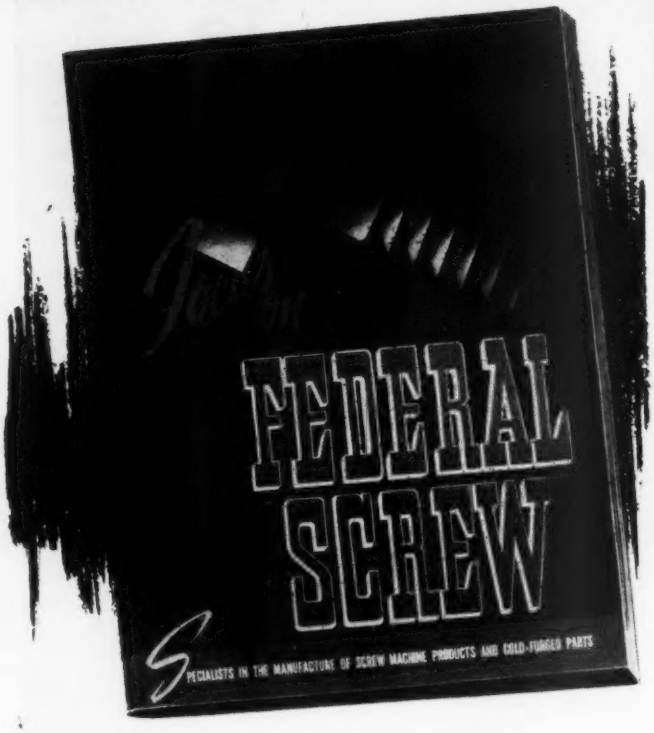
TO ALL USERS OF

SCREW MACHINE PRODUCTS



THIS large illustrated booklet shows at a glance what Federal Screw Works can do in the contract manufacture of screw machine products and cold-forged parts. There are many full-sized photos and sectional drawings of typical parts we're producing, involving all screw machine and secondary operations, plating, cold upsetting, etc.—the sort of work we can do for you to simplify your production problems—and a quick pictorial trip through the plant shows the facilities available to do it.

You'll be interested! Send for your free copy today—on your company letterhead, please.

ARMY (E) NAVY

Federal SCREW WORKS

DETROIT AND CHELSEA, MICHIGAN

MAIN OFFICES: 3407 Martin Ave., Detroit 10, Michigan

Oil Seals

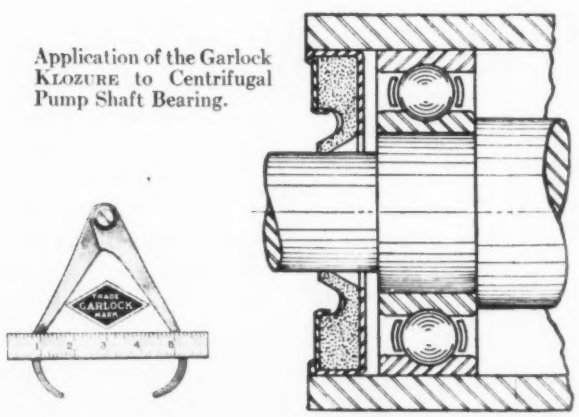
To Fit Standard Bearing Bores

The KLOZURE Oil Seal (Patented) is tough, dense, resilient; stays firm under severe conditions; resists oil and heat.

Garlock Metric O.D. KLOZURE Oil Seals are made in sizes to press-fit in S.A.E. or International millimeter bores as standardized by ball and roller bearing manufacturers. Designs for a great variety of applications; complete range of sizes. Write for catalog.

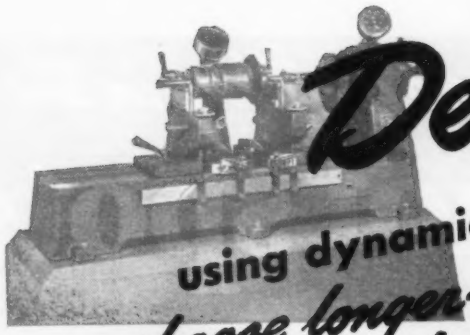
THE GARLOCK PACKING COMPANY, PALMYRA, N. Y.
In Canada: The Garlock Packing Company of Canada Ltd., Montreal, Que.

Application of the Garlock KLOZURE to Centrifugal Pump Shaft Bearing.



Garlock

KLOZURE OIL SEAL



Designers using dynamic-balancing in manufacture choose longer-lasting Dayton V-Belts for Smooth, Vibrationless Operation

So careful in their design, and in their construction is the Lau Blower Company, that they employ special Dynamic-Balancing Equipment to insure the absolute precision of every wheel and pulley.

And then their Blower-Filter units are driven intermittently, and at variable speeds; and must operate dependably, even after months of idleness, often in damp basements.

Their power-transmission drives, therefore, must meet exacting requirements. They must be infinitely smooth-running, vibrationless, and quiet! And must maintain the utmost efficiency throughout a very long life.

This *combination* of requirements was tough. It led to the "trying out" of many belts. The company, due to *actual experience* with Dayton V-Belts for years, has *now practically standardized on these V-Belts by Dayton!*

Elimination of "Stretch" and the Mechanically Correct Design of Dayton V-Belts give Designers

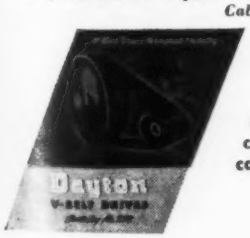
Power-Transmission of Unsurpassed Efficiency

With special "stretchless" Daytex Cords welded under tremendous tension into the neutral section of every Dayton V-Belt, and with every step of their manufacture technically controlled, Dayton V-Belts offer designers exceptional opportunities.

These V-Belts retain throughout their amazingly long life their unusually high efficiency. Dayton Rubber is the largest V-Belt Manufacturer in all the world.

You get FREE a copy of the Dayton Handbook described below. Send for it today. See for yourself how now you, too, can benefit; can depend upon the better-gripping, smooth-running, longer-lasting Dayton V-Belt Drives. Write, get your own FREE book, today.

THE DAYTON RUBBER MANUFACTURING CO., Dayton 1, Ohio
The World's Largest Manufacturer of V-Belts
Dayton Rubber Export Corporation, 38 Pearl St., New York, N. Y., U. S. A.
Cable Address: WIDBLOCO



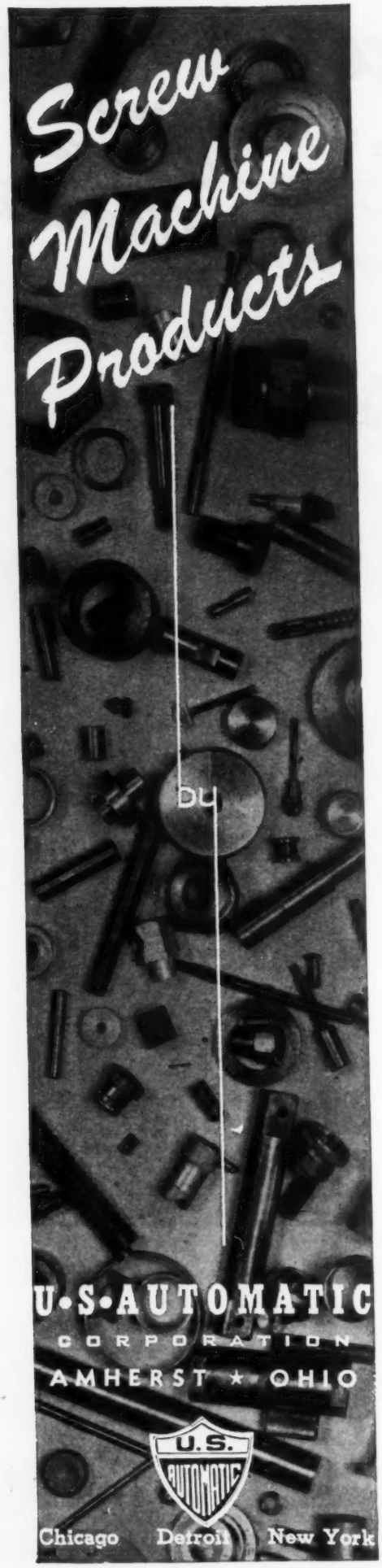
Dayton Rubber's new 384-page V-Belt Catalog is the most comprehensive encyclopedia of V-Belt Drive information and data ever published. Lists millions of drive combinations — everything you want to know without calculation or engineering. Write for free copy today.

KEEP ON BUYING WAR BONDS

V-Belts by Dayton Rubber

REG. TRADE MARK THE DAYTON RUBBER MFG. CO.

The Mark of Technical Excellence in Synthetic Rubber



Heat does not affect the all-metal An-cor-lox lock nut up to the softening point of the metal. What's your specific application? The correct metals or alloys can be chosen . . . so that locking efficiency will be unimpaired, even on an extreme high-temperature job. ● Similarly, corrosion-resistant metals may be selected for this one-unit lock nut construction. ● Write for the An-cor-lox story on new locking security—also for An-cor-lox sample.

An-cor-lox
TRADE-MARK REG
Lock Nuts

An-cor-lox Division
LAMINATED SHIM COMPANY
Incorporated
63 Union Street • Glenbrook, Conn.

2066

A Triple Range— OF HERRINGBONE PUMP ROTORS

150 GPM ROTEX PUMP, designed and built by Quimby Pump Division of H. K. Porter Company, Inc., Pittsburgh, Pa.; equipped with Farrel continuous tooth herringbone rotors.

1 MADE OF:

Bronze, high carbon steel, Meehanite, nickel iron, stainless steels.

2 FOR PUMPING:

Almost any liquid (including tar, paints, water and hot oils), air and gases.

3 FOR CAPACITIES:

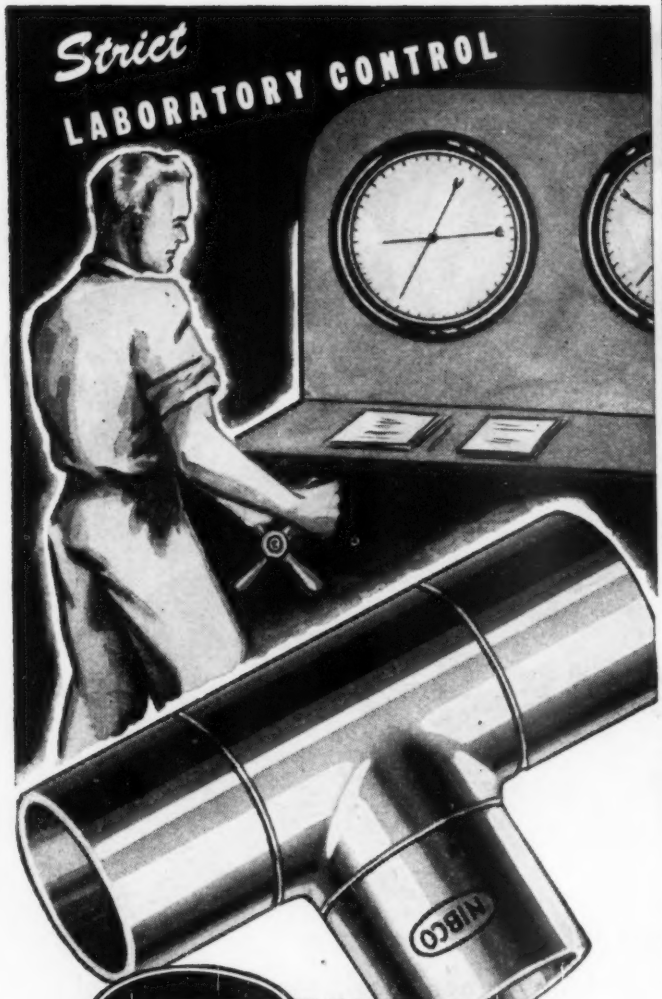
From 2 to 5,000 gallons per minute.

Precision cut by the famous Sykes gear generating process, Farrel continuous tooth herringbone pump rotors provide high volumetric efficiency and uniform flow without appreciable pulsation. There is no end thrust, no trapping of liquid, and when properly fitted in the pump housing, they run without noise even at high speeds.

Write for engineering data giving rotor sizes, formulas for determining capacities and other information. A request on your company letterhead will involve no obligation.

FARREL-BIRMINGHAM COMPANY, INC.
ANSONIA, CONN. BUFFALO, N. Y.
Plants: Ansonia and Derby, Conn., Buffalo, N. Y.
Sales Offices: Ansonia, Buffalo, New York, Pittsburgh, Akron, Los Angeles, Tulsa, Houston

Farrel-Birmingham

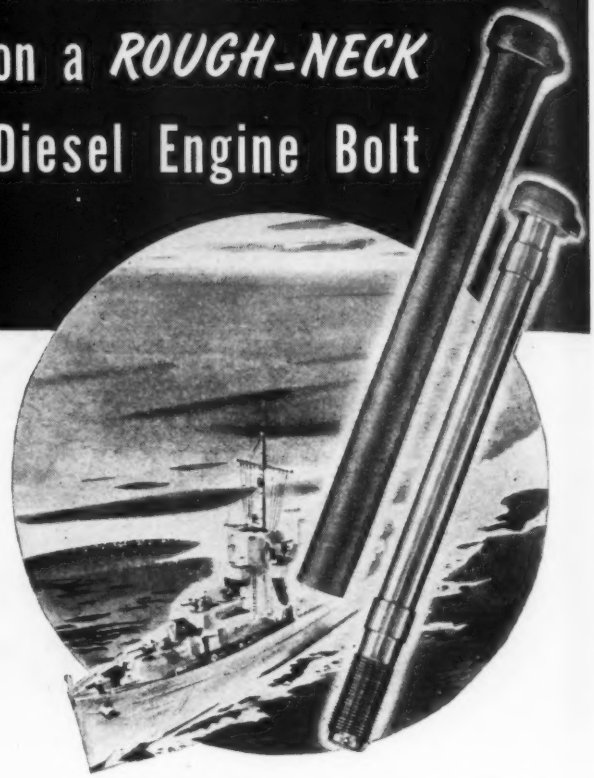


NIBCO WROT Fittings

WHEN designing new equipment for low production cost, remember NIBCO WROT and Cast Fittings and Valves or special tubular parts. Accurate manufacture and perfect sizing make alignment easy and save time. Formed in one step from straight copper, aluminum or stainless steel tubing under tremendous pressures . . . they are the finest solder fittings made . . . vibration-proof and impervious to gases. Not only are tolerances maintained by individual plug tests, but all NIBCO products are manufactured under strict Laboratory Control. Write for catalog and get acquainted with the many items in NIBCO's line that will help solve your design problems.

NORTHERN INDIANA BRASS CO.
ELKHART, INDIANA
VALVES AND FITTINGS SINCE 1904

A Jewel-like Finish on a *ROUGH-NECK* Diesel Engine Bolt



Whatever *YOUR* unusual precision parts job, Western offers you the ingenuity and skill to do it...*on a quantity production basis*

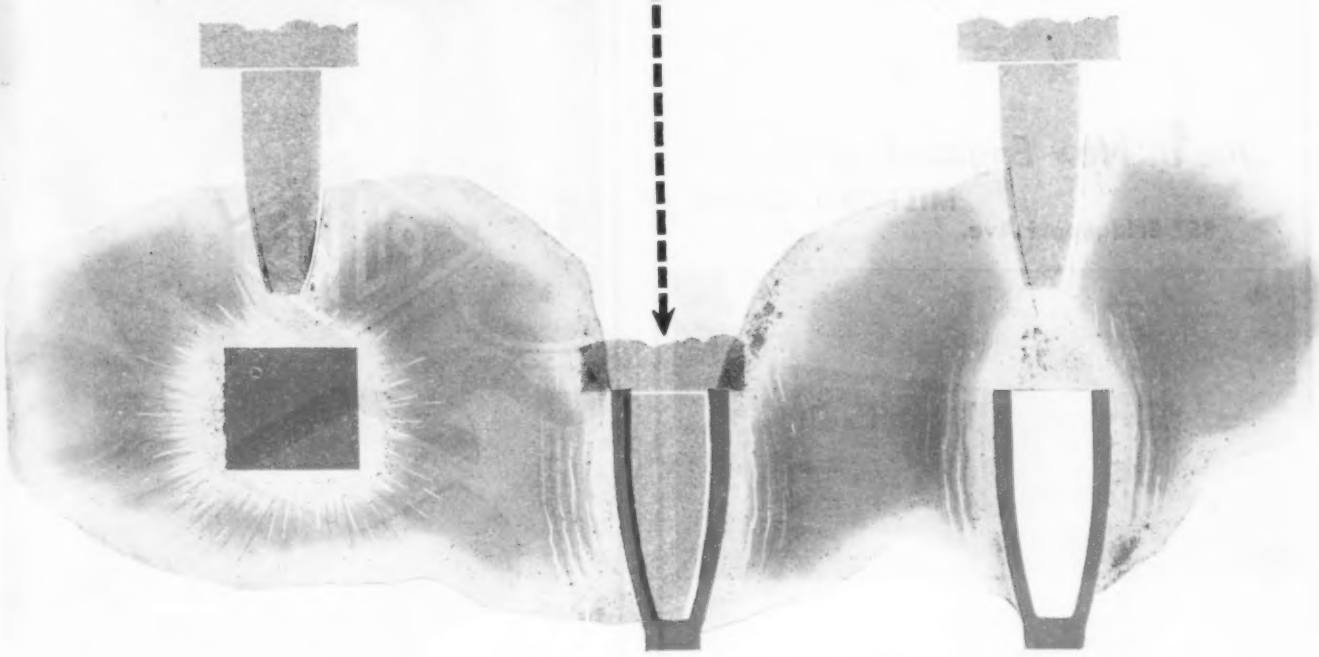
No fooling around on parts like these connecting rod bolts for Cooper-Bessemer 600 and 850 h.p. diesels that furnish power to Uncle Sam's naval units. Over 15″ long, 1½″ body diameter, they're turned and ground from rough forgings of heat-treated alloy steel. Five separate grinding operations assure jewel-like finish, free of tool marks. Specifications include class 3 ground threads and piece-by-piece Magnaflux inspection to catch hidden defects. Western produces them, fast and flawless — a good tip on where to send your precision parts jobs.

Western Complete Service — Special precision screw machine products to specifications. Capacity range. 1/16″ to 4 5/8″ round. Complete equipment for all types of secondary and processing operations — precision grinding, heat-treating, hardening, pentrating.

Western Automatic
Machine Screw Company
728 Lake Ave., Elyria, O.
Precision Parts and Assemblies Since 1873

PIERCING THE 81-MM SHELL

A "ONE SHOT" METHOD AT DRESSER



Quantity production of 81-mm trench mortar shell forgings was urgently requested by the War Department. Dresser's answer: a unique and speedy "one shot" method . . . by which 3⅜" round billets are pierced in one stroke of a hydraulic press.

High production, obtained with little equipment, is a result of the skill which Dresser has been accumulating since it began making rings and forgings for pipe couplings 65 years ago. This engineering skill is at your service . . . to help in the design of new products or the redesign of old ones . . . for producing precision parts or products in greater volume and at substantial savings in machining costs. Dresser has extensive facilities for manufacturing hydraulic press and upsetter forgings, including rough machining and normalizing of some items.

Inquiries are invited and will receive prompt attention.

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DRESSER MANUFACTURING DIVISION
Dresser Industries, Inc., Bradford, Pa.
In Canada: Dresser Manufacturing Co., Ltd., 60 Front Street, West, Toronto, Ontario.

Dresser Hydraulic Press and Upsetter Forgings

These are typical Dresser forgings . . . scientifically designed, and made close to finish machined dimensions . . . to reduce machining costs to a minimum.

DRESSER RINGS and FORGINGS

FASTENER SERVICE

NOW AVAILABLE AT TWO PLANTS

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One in New England, at

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Both are equipped to render specialized service on fastening problems to give prompt shipping service.

The **MILFORD RIVET & MACHINE CO.**

EASTERN DIVISION — CENTRAL DIVISION

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The Seal of Merit Symbolizes the Solution to your Sealing Problems

Seal rings developed by Pure Carbon are meeting the most exacting demands for efficiency. In applications where low friction, non-abrasive and long-lasting seal rings are a necessity, our carbon seal rings are demonstrating their superiority to the complete satisfaction of increasingly more manufacturers. Consult the Pure Carbon engineer in or near your city. He'll gladly co-operate with you in working out the answer to your sealing needs.

SEND FOR NEW BOOK DEFINING USES OF CARBON SEAL RINGS

PURE

Pure Carbon Co., Inc.

2102 Nobrac Street

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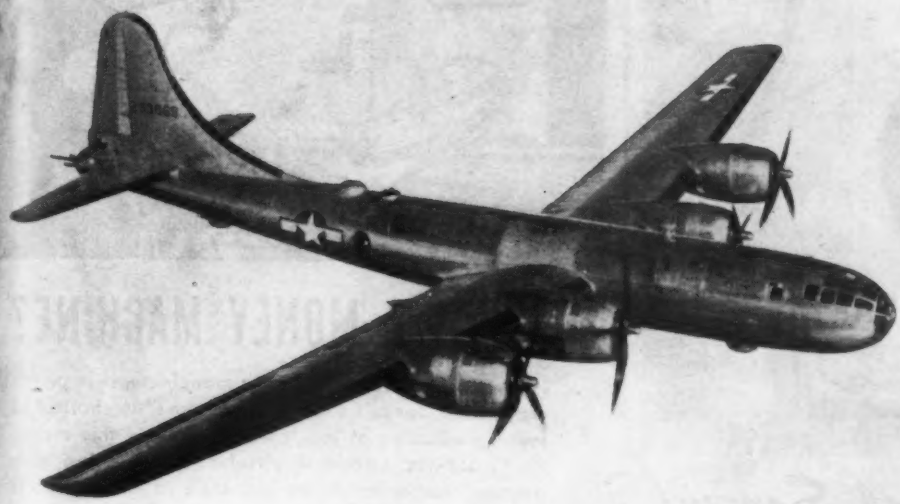
SPEED NUTS OVER TOKYO



Boeing uses thousands of SPEED NUTS on every B-29 Superfortress to' make them lighter, faster and deadlier.

Photos courtesy of Boeing Aircraft Company

SPEED NUTS HELP THESE BOEING WORKERS BOOST B-29 PRODUCTION

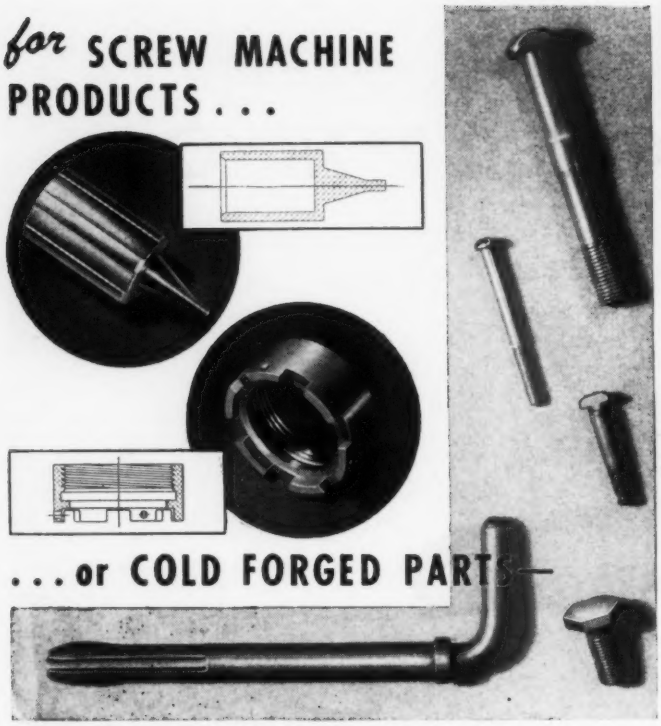
TINNERMAN PRODUCTS, INC.
2041 Fulton Road, Cleveland 13, Ohio

In Canada: Wallace Barnes Co., Ltd., Hamilton, Ontario *In England:* Simmonds Aerocessories, Ltd., London

Speed Nuts
PATENTED
*Trade Mark Reg. U. S. Pat. Off.

FASTEST THING IN FASTENINGS

for SCREW MACHINE PRODUCTS . . .



. . . or COLD FORGED PARTS—

FOCUS ON *Federal Screw!*

For screw machine products and cold-forged parts, Federal Screw Works may well be your most logical source of supply. Our extensive plants are fully equipped for all screw machine and second-operation work, and for widely varied cold-forging and thread-rolling jobs as well. And we have the specialized skill and experience to meet your most exacting needs . . . in any volume . . . and right on schedule.

Our manufacturing specialists will be glad to work with you on both your present and post-war production problems. Without obligation on your part, let's sit down and talk it over—*now!*

One of the First

SIX TIME WINNERS OF THE ARMY-NAVY "E"

In January of this year, 48 concerns throughout the country were the first to receive a fifth star for their Army-Navy "E" flags. Federal Screw was among those to be honored. Since the award of the Navy "E" burgee early in 1942, this company has maintained its record of high production achievement since the earliest days of the war.

ARMY E NAVY

CHELSEA DIVISION

Federal SCREW WORKS

DETROIT AND CHELSEA, MICHIGAN

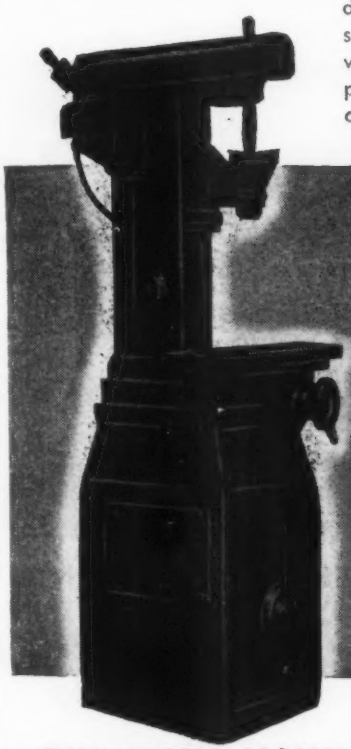
MAIN OFFICES: 3401 Martin Ave., Detroit 10, Michigan

WHAT! A MONEY MACHINE?

. . . well, not exactly, but a manufacturer is plumb crazy if he doesn't explore every possible shortcut to more production at less cost. Frequently this means new machines; scrapping obsolete models; designing new and better machines and tools to turn out parts and products.

For three generations Fenn has been designing and building machines that lick production costs — hundreds of machines from printing presses to paper cup machines — each one saving time and money for the user.

If your present equipment is obsolete and inefficient judged by today's production requirements, scrap and start fresh. Don't wait for the spur of competition. Plan now by consulting with Fenn.



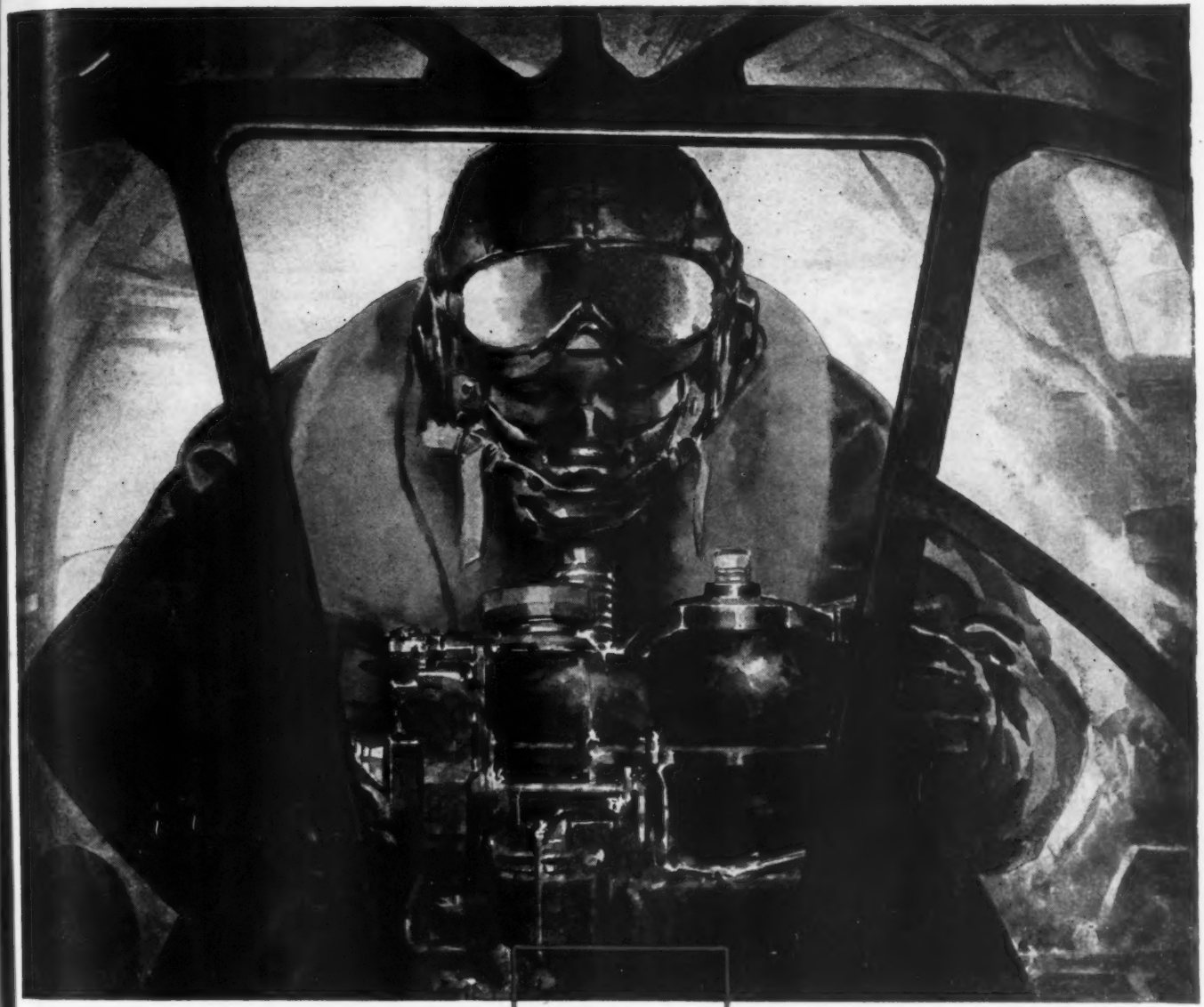
FENN

- TOOLS
- FIXTURES
- MACHINE PARTS
- SPUR GEARS
- INTERNAL GEARS
- GUN PARTS
- AIRCRAFT PARTS
- SUB-ASSEMBLIES
- QUICK ACTION VISES
- SPECIAL MACHINERY

THE FENN MANUFACTURING CO.

HARTFORD, CONNECTICUT

Special Machinery For Efficient Production



When you set your sights on tomorrow's competition

CONSIDER your competitors as of tomorrow. What will they put forward in the way of improvements? What will your product need to match or exceed their progress? Today, in the deadly competition over enemy territory, forgings are giving our fliers a decided advantage. The same Tube Turns skill that fashioned those forgings is available for the improvement of your products.

Here, under one roof, are the engineering talent, the upset, press and mechanical forging equipment and the precision heat treating facilities that have achieved new successes with steel, aluminum and light alloys.

Whether you are concerned with the improvement of your present product or with developing wholly new ideas, you are invited to submit your problem, without obligation. TUBE TURNS (Inc.), Louisville 1, Kentucky.

TUBE TURNS *Forgings for Industry*

26 NOSES FOR THE LUNGS OF A B-29

The pressurized cabin ducting of each B-29 consists of 26 Rex-Flex stainless-steel units. Safely, surely, Rex-Flex provides the very breath of life for Superfortress crews in the substratosphere.

The Bell-fabricated B-29 is the most dangerous type of bomber in the air—but only for our enemies. Safety of the men that fly Superforts comes first in Bell's huge Georgia plant . . . every single part that goes into the B-29's—regardless of size—is the finest to be had. That's why Rex-Flex stainless-steel ducting was chosen for all B-29 pressurized cabins.

Rex-Flex is *dependable.* Above 30,000 feet—where unbalanced pressures would take a crushing toll of other materials—this stainless-steel life-line is non-collapsible. Rex-Flex not only has maximum durability but is the most leakproof and fireproof ducting suitable for aircraft use. And even installation is better because Rex-Flex is manually bendable in multiple planes. Here are some of the reasons why Rex-Flex is the flexible tubing for *your* job:

- **Non-collapsible**
- **High crush strength**
- **Low line loss**
- **Airtight**
- **High vibration quality**
- **Fireproof**
- **Bendable in multiple planes**
- **Corrosion resistant**

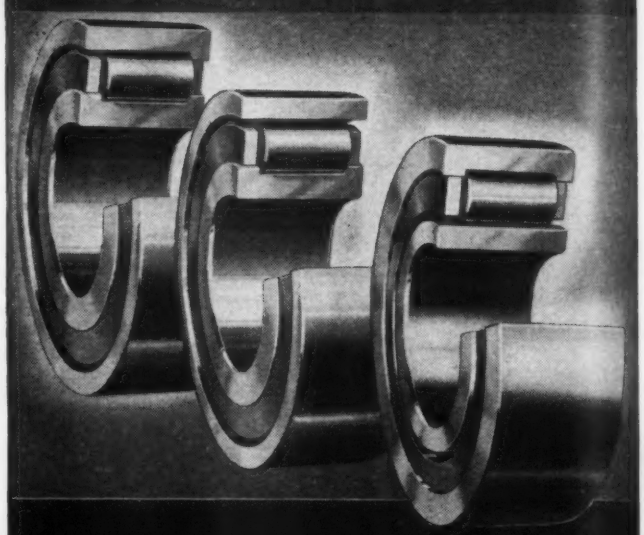
Industry has found many ways to profit from these extra Rex-Flex qualities—manufacturers have learned how to save time and money with this modern stainless-steel tubing. Let us show you how Rex-Flex can help in combating heat, corrosion or vibration in your products of today and tomorrow. Write now for full information.

Flexible Metal Hose for Every Industrial Use

CHICAGO METAL HOSE CORPORATION
MAYWOOD, ILLINOIS

Plants: Maywood and Elgin, Ill.

Specialized



FOR SUPER SERVICE

When we say *super* service, we mean just that! Because AMERICAN SUPER HEAVY DUTY ROLLER BEARINGS are *specially* built for applications requiring *super* strength . . . *super* performance . . . *super* endurance. They are not just "stock" bearings. Often they are designed to exact specification for the job they are required to do. Their vital, extra capacity to render continuous 24-hour-a-day performance in the heaviest equipment built, under the most adverse service conditions to be encountered in modern industry, is the reason why, for more than 25 years, AMERICANS have been first choice with manufacturers and designers of heavy industrial and oil country machinery. Once adopted, no manufacturer has ever had to switch from AMERICANS.

Write today for complete technical details.

AMERICAN ROLLER BEARING COMPANY

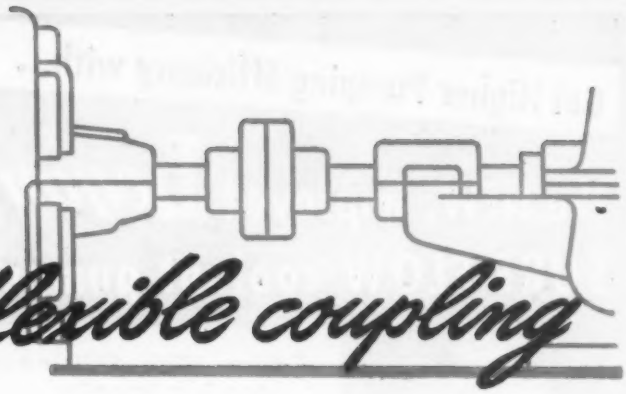
Pittsburgh **Pennsylvania**

1718 S. Flower St., Los Angeles, California

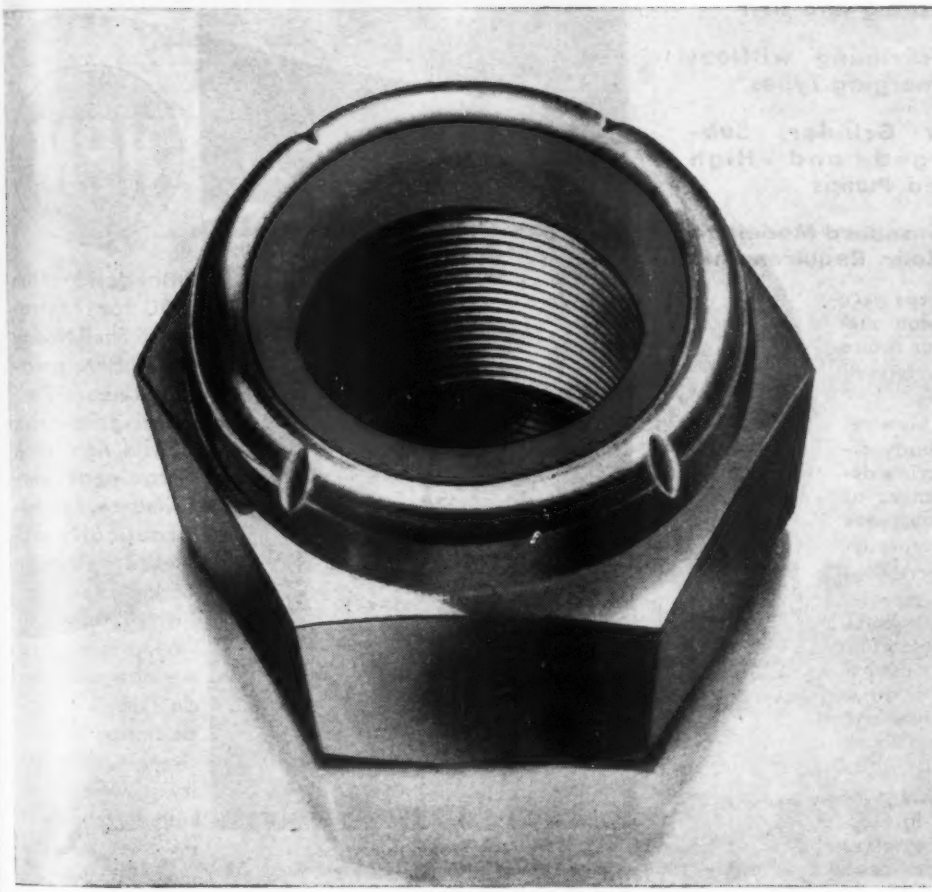
AMERICAN ROLLER BEARINGS HEAVY DUTY

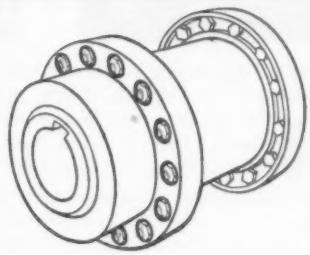
AMERICAN HEAVY-DUTY ROLLER BEARINGS

IT'S THE NATURAL THING



— for a flexible coupling





ESNA recommends Elastic Stop Nuts for both alignment and flexible alignment couplings that operate under conditions of vibration, impact, shock or stress reversal. Let us send an application engineer to discuss the Elastic Stop Nut way of avoiding possible nut failures on your flexible couplings—failures that may cause costly shutdowns or damage to equipment.

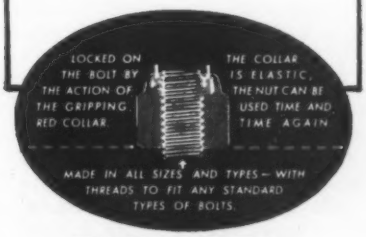
The Elastic Stop Nut uses its head. It has what it takes to stay put in a coupling, no matter how tough the operating conditions.

Built into the head of every Elastic Stop Nut is a locking device — an elastic compression collar.

This collar forms itself to the individual bolt thread, grips it tight. The nut won't loosen up or back off under conditions of severe vibration, shock or impact.

When you use Elastic Stop Nuts you need no cotter pins, no lockwashers or any other auxiliaries with their attendant increase in assembly and servicing costs. And you can turn them up to the torque you need and be sure they will stay there. No backing up or straining to find a cotter-pin hole. They can be used over and over again yet still lock. You can use them on any standard bolt.

Here is sure insurance against loose nuts which will result in reduced coupling maintenance costs.


LOCKED ON THE BOLT BY THE ACTION OF THE GRIPPING RED COLLAR
THE COLLAR IS ELASTIC. THE NUT CAN BE USED TIME AND TIME AGAIN
MADE IN ALL SIZES AND TYPES — WITH THREADS TO FIT ANY STANDARD TYPES OF BOLTS

ESNA

TRADE MARK OF

ELASTIC STOP NUT CORPORATION OF AMERICA

Union, New Jersey and Lincoln, Neb.

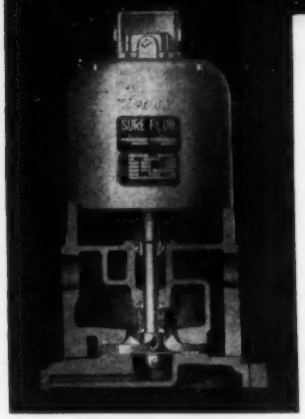
Sales Office—1060 Broad St., Newark 2, N.J.

ELASTIC STOP NUTS

Lock Fast to Make Things Last

Get Higher Pumping Efficiency with...

the NEW, improved Logan SURE-FLOW coolant pumps



- ✓ New High Efficiency Long Life Impeller
- ✓ Motor Sealed Against Splashing and Grit
- ✓ Self-Priming without Submerging Types*
- ✓ New Grinder, Submerged and High Speed Pumps
- ✓ 27 Standard Models to Fit Your Requirements

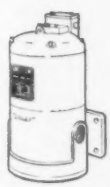
For coolant pumping efficiency that keeps pace with today's fast-cutting, high precision machines . . . for peak performance in your future developments . . . specify the new, *improved* Logan SURE-FLOW Centrifugal Pumps.

This outstanding coolant pump has been re-engineered from top to bottom to embody exclusive new features and Logan engineering developments. By applying these advantages to your work, you will help your modern machines and cutting tools to operate at maximum capacity.

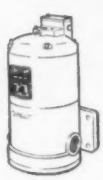
The open, unloading type impeller of improved design discharges air or vapor rapidly. There are no close tolerances or metal-to-metal contacts of running parts . . . liquids containing some abrasives, filings or other foreign matter can be handled safely. The integral motor drive permits the SURE-FLOW pump to be mounted anywhere. No gears, chains or other mechanical drive are required.

Foot and bracket mounted models are *self-priming without submerging* . . . can be located above or below the liquid level, or remote from the supply. The Logan line also includes new *grinder* and *submerged* type pumps, as well as *high-speed* models for driving stream, deep hole drilling and chip flushing applications.

*FOOT MOUNTED



*BRACKET MOUNTED

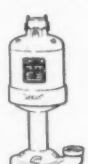


FLANGE MOUNTED (intake thru flange)

Available in 5 Types

Logan SURE-FLOW Coolant Pumps are now available in 5 mounting types and 27 standard models to fit a wide range of applications. Obtain these profitable advantages for your equipment . . . investigate SURE-FLOW pumps today.

GRINDER TYPE (intake thru flange)



SUBMERGED TYPE

ARMY-E-NAVY

Logan

Air and Hydraulic Equipment

LOGANSPORT MACHINE CO., INC. 912 PAYSON RD. LOGANSPORT INDIANA

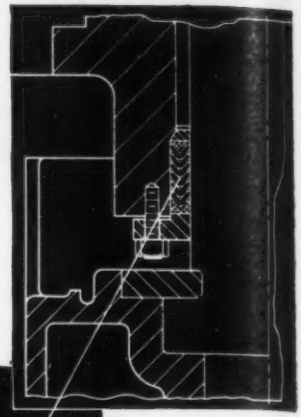
CHUCKS • CYLINDERS • VALVES • PRESSES • SURE FLOW COOLANT PUMPS

FREE Catalogs...Write for literature covering items in the Logan line in which you are interested.

A NAME TO REMEMBER . . .

LINEAR

"Par" Packings



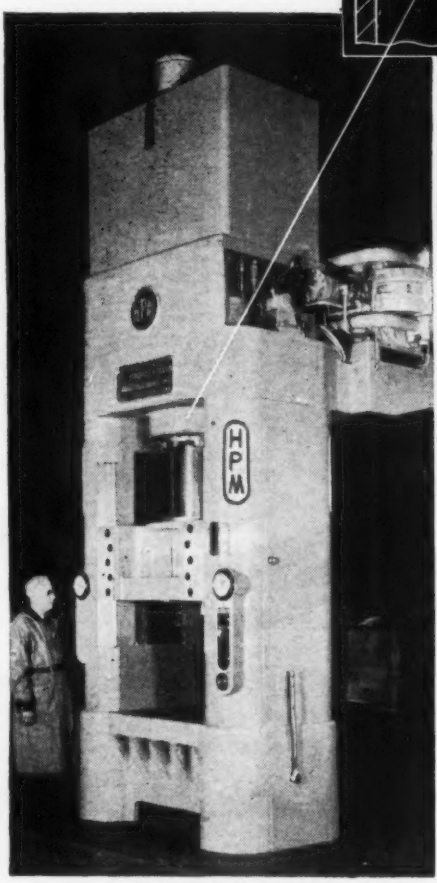


Photo & sketch courtesy of The Hydraulic Press Mfg. Co. Mt. Gilead, O.

HPM

In the design of this 350 ton Fastraverse Shell Nosing Press, HPM specified Linear "Par" packings to insure a fluid tight seal.

For peak performance, the hydraulically actuated mechanism of the press must be carefully controlled throughout the operating cycle. Linear "Par" packings effectively confine the hydraulic fluid, helping to deliver at the ram the maximum pressing force produced.

This thoroughly dependable seal, from zero to peak pressure, is attained by the precision design, exacting production methods and meticulous inspection of Linear "Par" packings. Manufactured from six compositions, each for a specific service, these packings are selected by designers of a wide variety of the most modern hydraulic equipment.

Sample packings sent upon request. Engineering consultation, resources of our testing laboratories and facilities for the complete design of the hydraulic unit itself are available. Keep Linear in mind . . . it's a good name to remember.

LINEAR

PACKING & RUBBER CO.

STATE ROAD & LEVICK STREET

TACONY, PHILADELPHIA 35, PENNA.

MEMO...from the desk of Exec. Vice President.

Att. Advertising Dept.

INVOLUTE
SPLINE GAGES
BY VINCO

"Setting by Tiffany" — "Gage Blocks by Johansson" — names that because of consistent perfection inspire confidence in the product — the ultimate goal of every conscientious manufacturer — Vinco has qualified for this select group — for instance, "Involute Spline Gages by Vinco" — even competitive consensus agrees that we lead the field in this branch of gaging — we pioneered involute spline gages — we developed grinding, lapping and control methods — exclusively Vinco — that produce involute spline plugs and rings so consistently perfect that "Involute Spline Gages by Vinco" is an accepted standard wherever gages are used.

E. E. Butler

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Semi-Automatic Hydraulic Spline and Gear Grinder • Optical Master Inspection Dividing Head • Involute Checker • Angle Tangent to Radius Dresser • Index Plates • Precision Vises • Sine Bars • Straight-side Spline, Serration Spline, Involute Spline and Helical Spline Plug and Ring Gages • Thread Plugs, Rings and Setting Plug Gages • Spur and Helical Master Gears • Munition Gages • Propeller Hub Gages • Built-up and Special Gages • Gear Rolling Fixtures • Spline and Index Fixtures • Hydraulic Power, Control, Utilization and Distribution Units • Engineering, Design and Development.

BENDIX

HYDRAULIC SURGE CHAMBER AND ACCUMULATOR

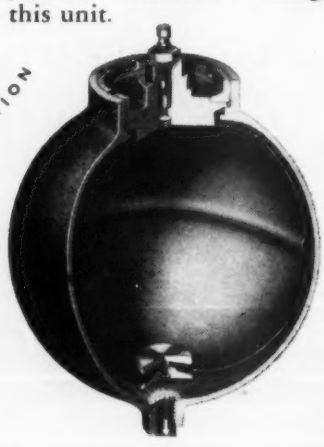
The exclusive design and construction of the Bendix Hydraulic Surge Chamber and Accumulator has demonstrated its safety, reliability and simplicity in over 51,000 installations.

Bendix engineers have utilized the utmost in the inherent stress efficiency of a spherical shell. The shell is continuous past the equator. This means that stress is not carried in an offset location, bending moments are avoided and flanges are entirely eliminated. *There is no known record of a shell bursting in service,* even under working pressures up to 3000 p.s.i.

The unit may be used either as a surge chamber to absorb excessive shocks thrown on the hydraulic system, or as an accumulator to provide high instantaneous rates of discharge.

Write Dept. 7, Pacific Division of Bendix today for complete data, indicating the conditions under which you are interested in using this unit.

Pacific Division
BENDIX AVIATION CORPORATION
NORTH HOLLYWOOD, CALIFORNIA



Fluid and air are separated by a flexible bladder of unconventional design which can be easily serviced by removal of the air cap. Hydraulic oil is charged through the oil port, compressing the air in the bladder and relieving dangerous shocks on the system. Used as an accumulator, this oil is released under pressure for system use.

LOOK INTO GAST ROTARY AIR MOTORS

as Standard Equipment for Your Machines

SIMPLE, trouble-free operation. No springs behind vanes, shaft packing does not require adjustment.

COMPACT. Unbelievable power in proportion to small size.

ALWAYS EFFICIENT. Automatic take-up for wear is a feature inherent in rotary design.

AVAILABLE. Low in cost, good delivery on essential industrial applications.

VARIABLE SPEED easily controlled by varying air pressure.

NO SPARKS, therefore explosion-proof. Meets all safety requirements.

CAN'T BURN OUT by over-loading —no matter how frequently or suddenly it is stopped.

● Investigate for yourself why so many manufacturers are using Gast Rotary Air Motors in explosion-proof applications and others where compressed air is available—both in their own plants and as part of machines they manufacture.

You will find that Gast Air Motors have many special advantages, including those inherent in Rotary design. A few are shown here. For the complete "inside story" send for the new descriptive folder "Industry's Trend to Air for Power".

If you are designing or building machines or devices where air motors are being considered, why not order

A SAMPLE MOTOR FOR TEST

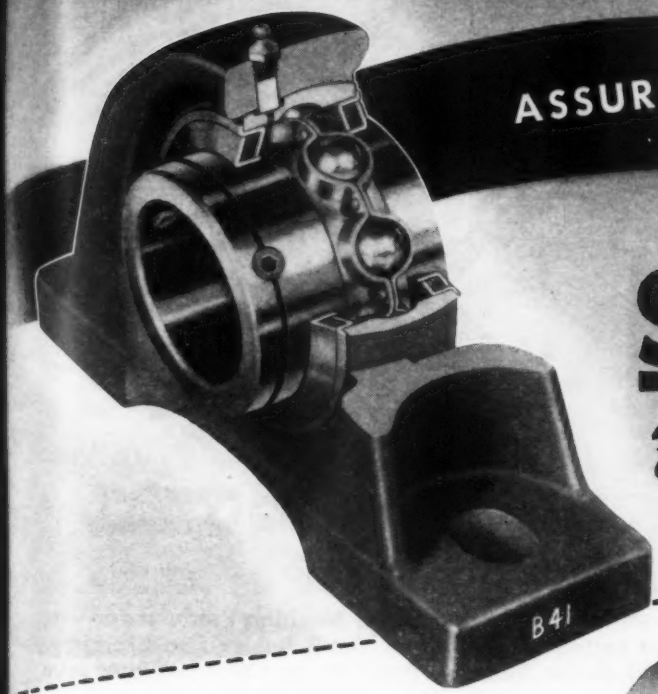
or let us have one of our engineers call on you for the purpose of helping you determine how Gast Rotary Air Motors may be used to improve performance. Write, phone or wire.

GAST MFG. CORP., 139 Hinkley St., Benton Harbor, Mich.

GAST ROTARY AIR
MOTORS • COMPRESSORS
VACUUM PUMPS

EXCLUSIVE FEATURES...

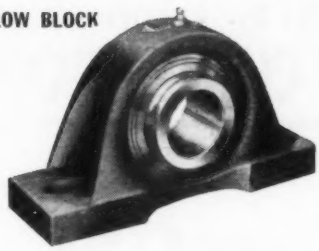
ASSURE TOP PERFORMANCE

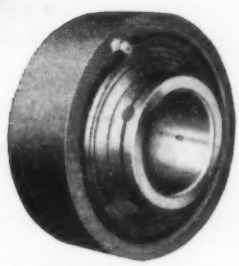


SEALMASTER

Ball Bearing Units

PILLOW BLOCK





CARTRIDGE UNIT

FLANGE UNIT

FLANGE CARTRIDGE UNIT

Permanently Sealed . . . Self-Aligning
Pre-Lubricated . . . Quiet Operation

Design Engineers, whether designing new or re-designing old products, will find that the combination of exclusive SealMaster features, offer a distinct advancement in bearing performance. Important features found in all SealMaster units include:

Permanently Sealed—A patented sealing principle *keeps out dirt* and *retains lubricant.*

Self-Aligning—Shaft mis-alignment in any direction cannot distort the seal.

Pre-Lubricated—SealMasters are shipped with lubricant sealed in—ready for immediate service.

No Outer Race Rotation—A patented locking pin keeps outer race from rotating in housing and allows re-lubrication of the bearing.

Quiet in Operation—SealMaster design and construction produce a bearing unusually quiet in operation.

Request a copy of catalog No. 840 for dimensions, load ratings and engineering data on the complete SealMaster line.

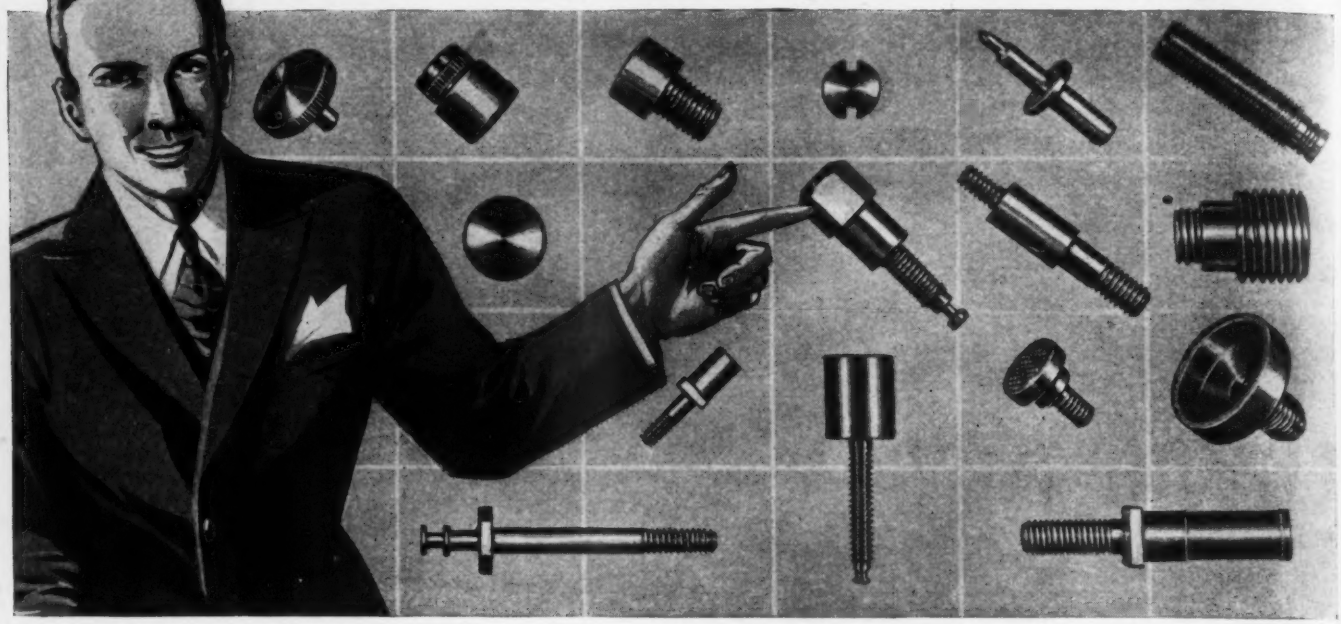
BEARING DIVISION

STEPHEN S-A ADAMSON MFG. CO.

9 RIDGEWAY AVENUE, AURORA, ILLINOIS — LOS ANGELES, CALIF. ★ BELLEVILLE, ONT.

Factory Representatives and Dealers in All Principal Cities

Is this the product you couldn't get?



If you're finding it hard to keep supplied with turnings, screws, pins and other Screw Machine Products for war production, tell us about it. If we can possibly help you, we certainly will. If not, we'll tell you so promptly. Our engineers will also be glad to help you to plan the right Screw Machine Products and Springs into your postwar designs.

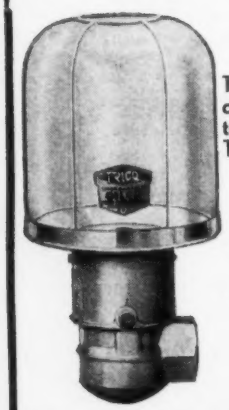
THE PECK SPRING CO., 14 Summitt St. PLAINVILLE, CONN.

Peck SPRINGS & SCREW MACHINE PRODUCTS

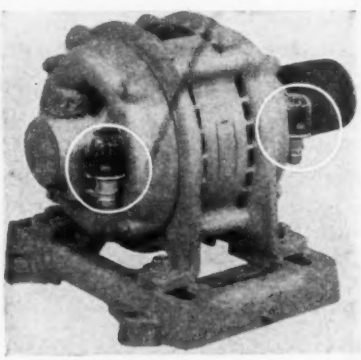
TAKE THE *Guess* out of OILING

TRICO Visible Automatic OILERS

- Stop guesswork of hand-oiling
- End bearing failures
- Step up production
- Modernize your equipment
- Increased customer satisfaction



The most certain way to give your customers complete freedom from bearing maintenance troubles and safeguard costly investments. There's a style for every application.



This motor is modernized with OPTO-MATIC constant level OILERS. Visible oil supply — no guesswork.

Write for Catalog
TRICO FUSE MFG. CO., MILWAUKEE 12, WIS.
In Canada — IRVING SMITH LTD., Montreal

INSTALL TRICO OILERS
REG. U.S. PAT. OFF.

"COMMERCIAL"

The "KNOW HOW" of forming Stainless Steel

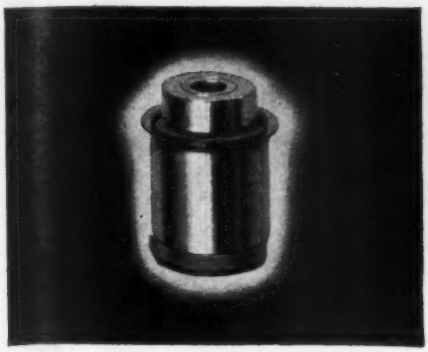
Chromium Nickel Alloys are readily formed cold, but a certain "Know How" is required, as stainless has certain characteristics that ordinary steels do not have . . . they are stiffer, harden quickly when worked in dies, and have a "spring" due to high elastic limit. So you must have the "Know How," what kind of dies, drawing compounds, press speed, pressures, etc.

We have it . . . been forming stainless for years. If stainless stampings are your requirements, send us your inquiries.

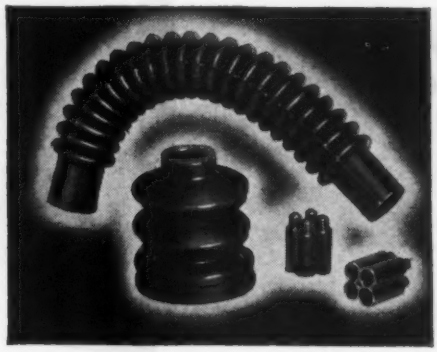
THE COMMERCIAL SHEARING AND STAMPING COMPANY.
YOUNGSTOWN · 1 · OHIO · U.S.A.

Rubber Engineered by GENERAL

One entire General plant, at Wabash, Ind., and its Engineering Department specialize on mechanical rubber goods, some of which are shown here. If your products use rubber parts, General engineers can help you specify the rubber and design applications for highest efficiency. Broad experience and ample facilities qualify General as a dependable source for your needs in precision-engineered rubber goods. The General Tire & Rubber Co., Mechanical Goods Division, Wabash, Indiana.



SILENTBLOC Vibration Mountings give engineered accuracy in control of vibration and shock load in motors and equipment.



MOULDED RUBBER parts of any size, shape and type of rubber, to meet your specifications for accuracy and performance.

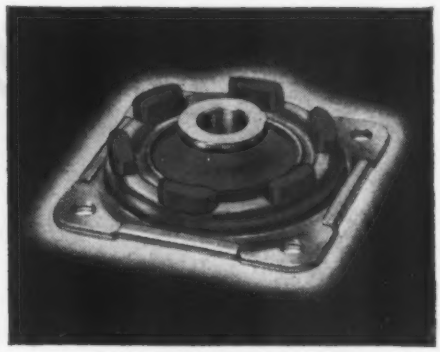
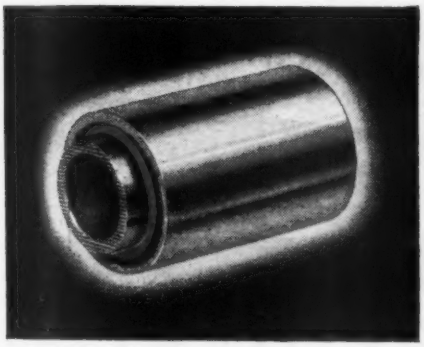
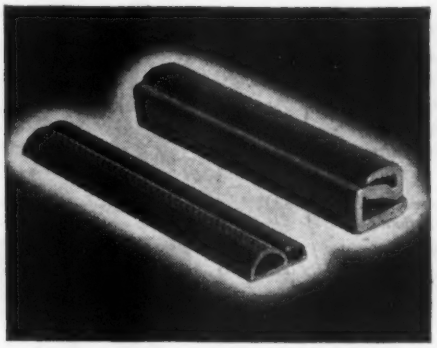


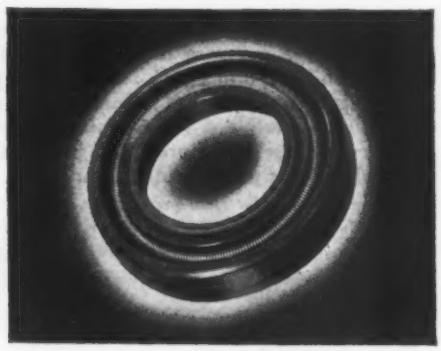
PLATE MOUNTS of any metal and rubber, for vibration isolation in aircraft, radio, electrical equipment, instruments.



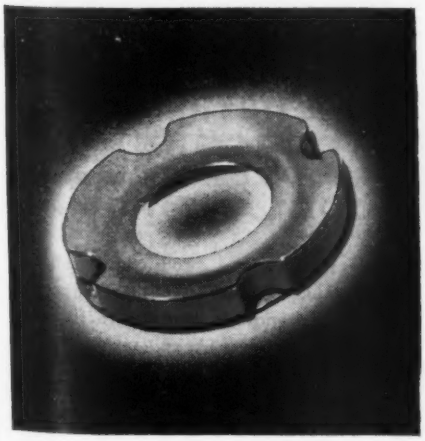
SILENTBLOC BEARINGS for oscillating equipment—need no lubrication, work silently, long lasting, unharmed by dust or liquid.



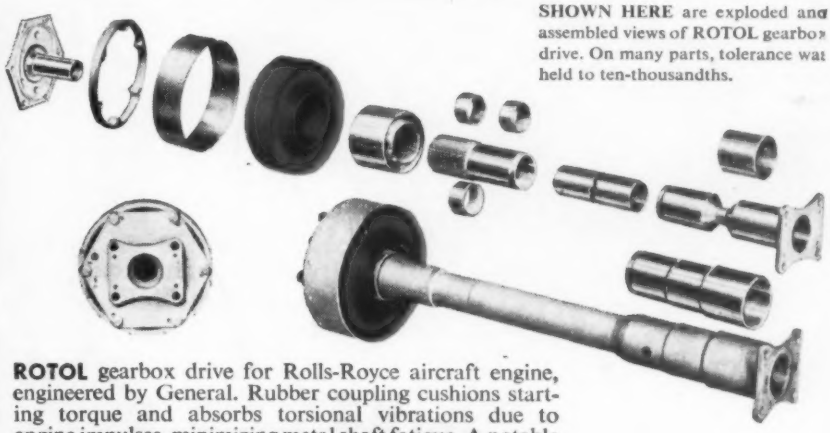
EXTRUDED RUBBER in any solid or hollow shape, made accurately to your specifications from any type of rubber.



OIL SEALS for lubricant and hydraulic applications, engineered to meet your needs in efficiency and long service.



RUBBER-bonded-to-metal parts of all kinds, made to specification. In ROTOL drive, shown at right, rubber is bonded to metal.



SHOWN HERE are exploded and assembled views of ROTOL gearbox drive. On many parts, tolerance was held to ten-thousandths.

ROTOL gearbox drive for Rolls-Royce aircraft engine, engineered by General. Rubber coupling cushions starting torque and absorbs torsional vibrations due to engine impulses, minimizing metal shaft fatigue. A notable example of General's skill in precision engineering.

MECHANICAL GOODS DIVISION • WABASH, INDIANA

THE GENERAL TIRE & RUBBER CO.

Makers of America's Top Quality Tire

A LESSON FOR NEW PRODUCTS

MANY A MACHINE BUILDER has learned under wartime pressure the amount of machining that Laminum shims save . . . and new peacetime products will benefit! (1) Quicker fitting of bearings, gear mesh, etc. (2) Certainty of uniform accuracy because of the precision gauge of the laminations. Want performance data?

Laminum shims are cut to your specifications. For maintenance work, however, shim materials are sold through industrial distributors.

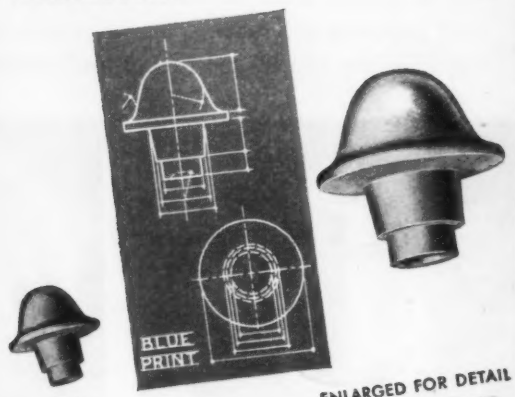
Laminated Shim Company, Incorporated
63 Union Street • Glenbrook, Conn.

LAMINUM
THE SOLID SHIM THAT peels FOR ADJUSTMENT

2223

ANOTHER SPECIAL BY PROGRESSIVE

QUALITY PROMCO BRAND



ACTUAL SIZE

ENLARGED FOR DETAIL

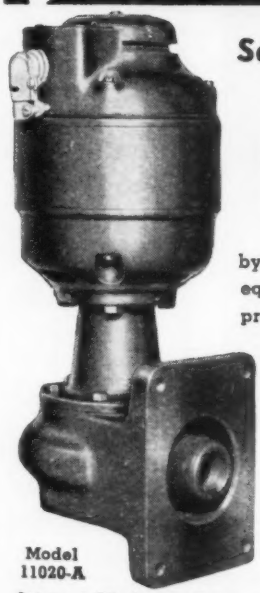
71 other "specials" are illustrated in Catalog 18, which includes tables of weights per 1M standard pieces, dec. equivs. of fractions, etc. Write for it.

Special heads, threads, and finishes — on fastenings of any metal or alloy adapted to cold-upset — are Progressive's specialty. Weekly output: 25,000,000.

The PROGRESSIVE MFG. CO.
48 NORWOOD ST., TORRINGTON, CONN.

★ BONDS BUY MORE WAR BONDS ★

TRUSTWORTHY



Save money and time with

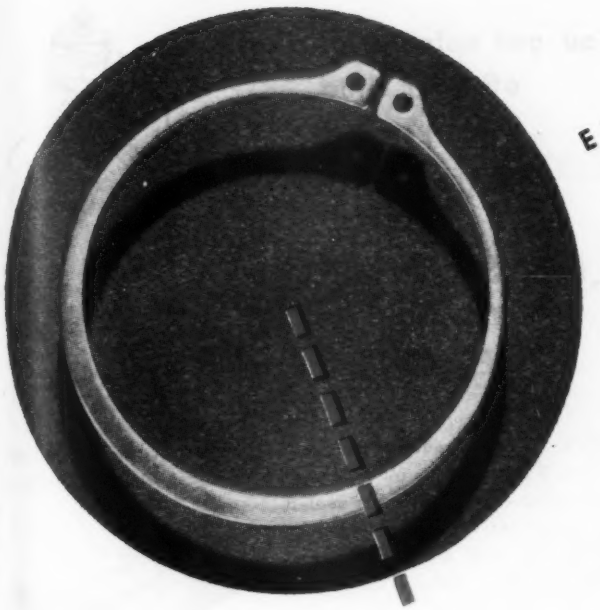
RUTHMAN
GUSHER
COOLANT PUMPS

by increasing the productivity of your equipment. Gusher Coolant Pumps have proved dependable under gruelling conditions—have been tested through years of operation in many plants. Insure yourself the latest in coolant pumps by specifying Gusher Coolant Pumps.

A complete line of immersed, pipe-connected, flanged-mounted, plain-drive and tank-unit types. Write for Catalogue.

Model 11020-A
Internal Discharge Type

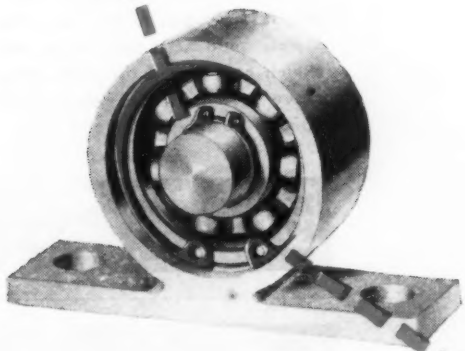
THE RUTHMAN MACHINERY CO.
1813 READING ROAD CINCINNATI 2, OHIO
The "GUSHER"—A Modern Pump for Modern Machine Tools



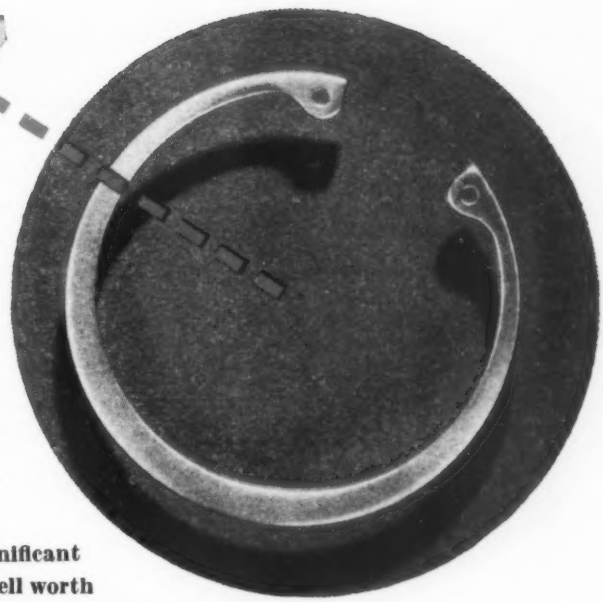
EXTERNAL TYPE NAS-51

WALDES TRUARC RETAINING RING

U. S. PATENT RE. 18,144



INTERNAL TYPE NAS-50



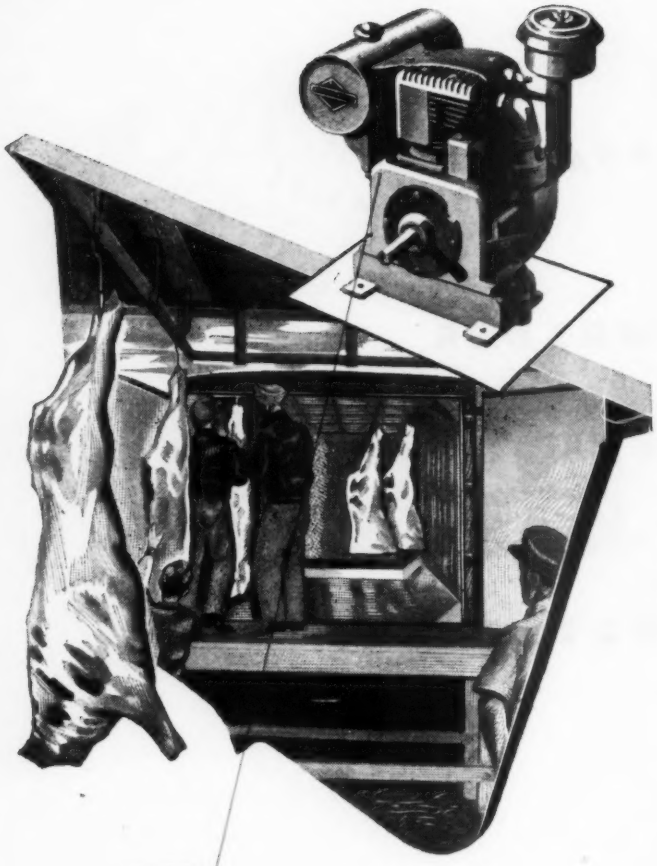
Waldes Truarc expands or contracts without distortion and without permanent set, fitting tight all around the groove. It offers important advantages over shoulders, nuts, collars, etc., for all thrust-load fixings in shaft and housing applications. It saves space, weight, assembly time and machining costs.

Waldes Truarc presents a significant advance in retaining rings, well worth your thorough investigation. We will gladly furnish samples and full data for tests, upon request.
Internal type National Aircraft Standard 50.
External type National Aircraft Standard 51.

THE SYMBOL OF QUALITY
WALDES

WALDES KOH-I-NOOR, INC.

Long Island City 1, N. Y. • Canadian Representatives: Prenco Progress & Engineering Corp., Ltd., 72-74 Stafford St., Toronto



Beef for Battling Yanks Overseas

Red meat — beef — and other perishable foods for our red-blooded, hard fighting Yanks are rushed to them in refrigerated trucks from supply depots. Refrigeration units are powered by performance-proved *air-cooled* gasoline engines — one more of many war uses for dependable, instant-starting Briggs & Stratton engines.

Air-Cooled Power — 4 CYCLE BRIGGS & STRATTON GASOLINE ENGINES

The performance records established by more than two million Briggs & Stratton engines are conclusive proof of their perfection in design, fine engineering, and precision manufacture. Current models, and those to come, are backed by the "know how" gained through 25 years of *continuous* production of *Air-Cooled* Gasoline Engines. Briggs & Stratton Corp., Milwaukee 1, Wis., U.S.A.

ARMY-NAVY "E"

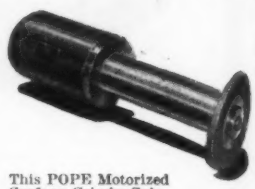
You get spindle lubrication off your mind when you use

POPE

PRECISION SPINDLES
with lubrication
SEALED-IN

POPE Spindles require no attention for lubrication or adjustment. They have no oil cups, wicks or grease fittings for you to look after—the lubricant is sealed-in—good for the life of the bearings. Dirt and dust can't get in, lubricant can't get out.

Sealed-in lubrication is but one of the features that make it pay to standardize on POPE Spindles. Simply send us a description with sketch or outlined drawing. Then leave it to us to provide a POPE Spindle designed for your work.



This POPE Motorized Surface Grinder Spindle is an excellent example of the advantages of **sealed-in** construction. The motor as well as the spindle itself is completely sealed in. No chance for dust and dirt to cause damage to either motor or bearings.

22

POPE MACHINERY CORPORATION
ESTABLISHED IN 1900
HAVERHILL, MASSACHUSETTS
BUILDERS OF PRECISION SPINDLES

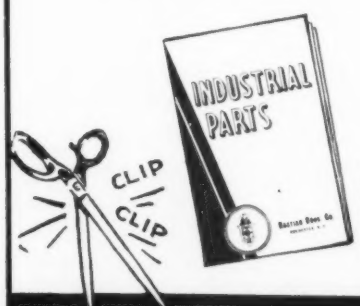
"TOPS" ANYWHERE!

BASTIAN'S INDUSTRIAL PARTS!

APPLICABLE TO ALL TYPES OF PRODUCTS

Whether a stove, refrigerator, an aircraft computor dial, radio or parking meter—Bastian's INDUSTRIAL PARTS in plastic or metal have what it takes to fill the bill.

Plastic parts can be printed in any number of colors—metal, in any desired finish.

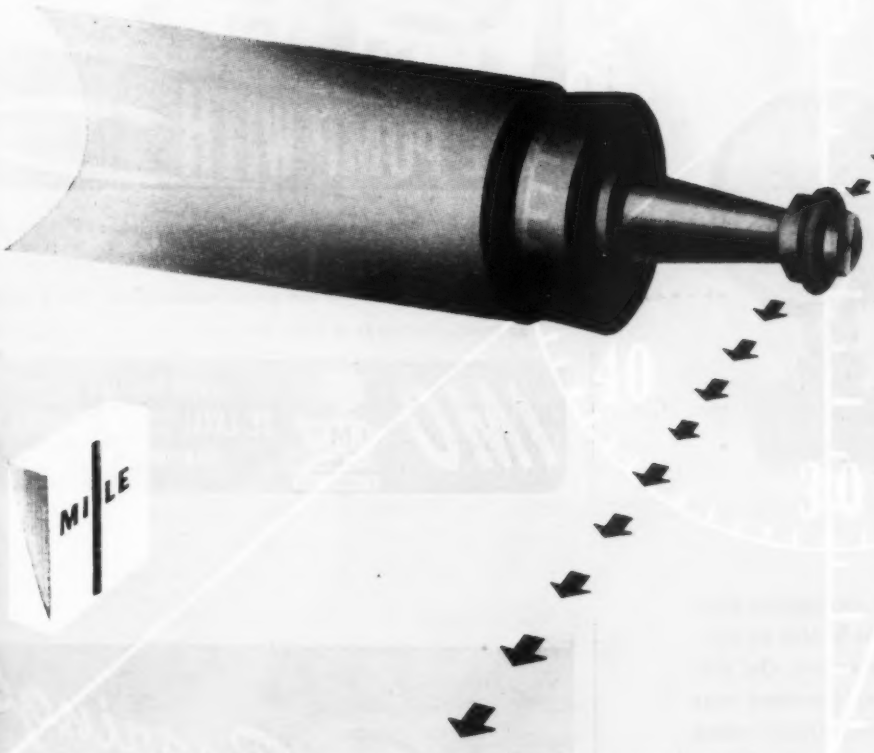


Just clip the coupon below, fill in and mail to us, we'll send free booklet, prices and samples by return mail.

BASTIAN BROS. CO.
Serving the trade since 1895
Rochester, N. Y.

NAME_____
TITLE_____
COMPANY_____
CITY_____ H

Sending a half-inch

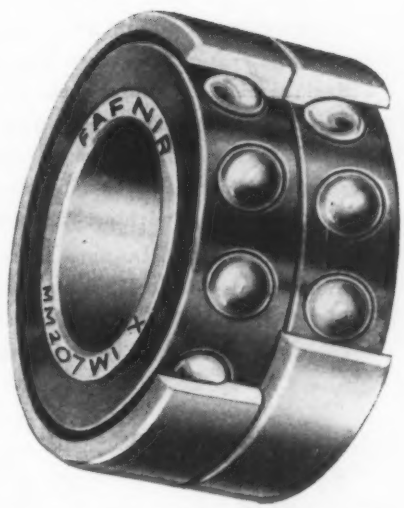


on a mile-a-minute errand

Getting 5000 peripheral feet a minute with a 4-inch grinding wheel poses no serious speed problems. But, to do that with a half-inch grinding wheel, speed must be stepped up to 40,000 r.p.m. And the maintenance of that speed hour after hour is a job for ball bearings.

More than that, it's a job for which Fafnir Super-Precision Bearings were specifically made. In the Fafnir Super-Precision Department, the "factory-within-a-factory," balls for these bearings are matched to unbelievable limits. And pairs of these bearings are matched so carefully that variations between assembled bearings are reduced to millionths of an inch. Properly mounted, these bearings eliminate harmful deflection, maintain inherent rigidity and give *truly accurate* production required today in so many industries.

The same Fafnir engineering skill and experience which made possible our own Super-Precision Department are available to help you lick your bearing problems. The Fafnir Bearing Company, New Britain, Connecticut.



MM200WIX SERIES
Extreme precision, preloaded duplex pairs, for speeds of 40,000 r.p.m. and more.

FAFNIR BALL BEARINGS
Most Complete Line in America

FOR BETTER PERFORMANCE

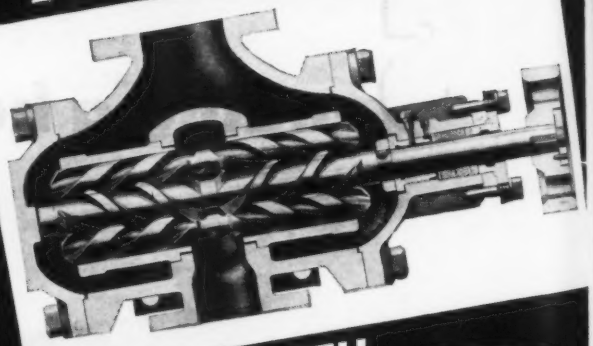
In planning air operated units, remember that such equipment often performs better at considerably less than full line pressure. Or, different operations on the same air operated unit will require an adjustment in working pressure for best performance. Hannifin Pressure Regulating Valves provide the accurate, dependable control needed for easier and safer handling. The exclusive piston-type design gives sensitive, accurate control of air pressures, adjustable over the entire working range to provide any reduced pressure desired. Piston-type design, with long valve stem travel, gives large volumetric capacity, meeting varying operating needs with minimum restriction to flow. The simple, dependable construction throughout means long life without maintenance.

Built in three standard sizes, 3/8, 1/2, and 3/4 inch, for use on initial air pressures up to 150 lbs. Write for Bulletin 56. Hannifin Manufacturing Company, 621-631 South Kolmar Avenue, Chicago 24, Illinois.

Hannifin

PRESSURE REGULATING VALVES

IMO

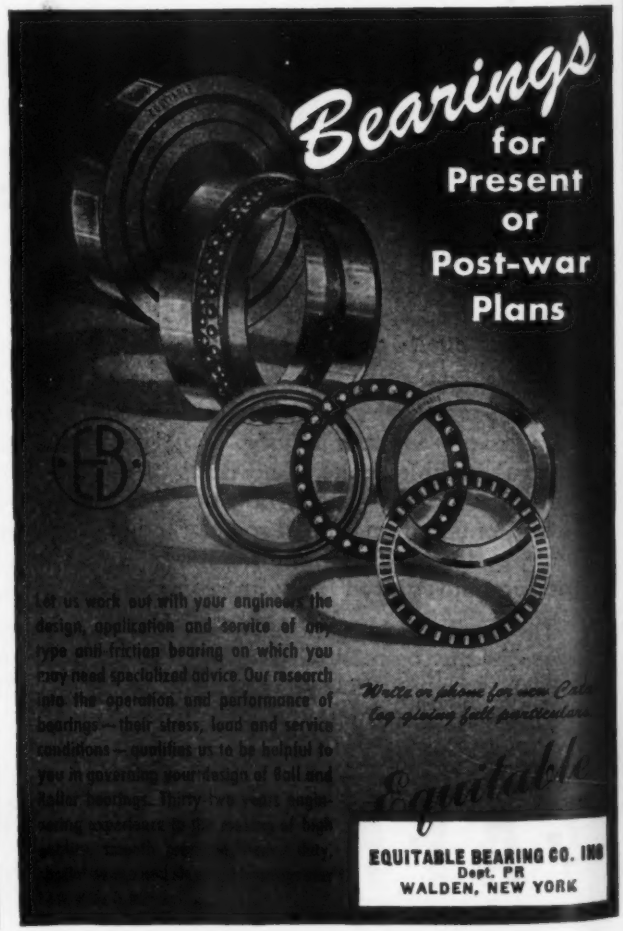


THE PUMP WITH

what it takes to combine a maximum of capacity, pressure and reliability with a minimum of space, weight and power consumption. That's why so many thousands of IMOs are used. I—121—G

IMO — IMO means I MOVE OIL

PUMP DIVISION OF THE
DE LAVAL STEAM TURBINE CO.
TRENTON 2, NEW JERSEY


Bearings
for
Present
or
Post-war
Plans
Let us work out with your engineers the design, application and service of our type anti friction bearing on which you may need specialized advice. Our research into the operation and performance of bearings—their stress, load and service conditions—qualifies us to be helpful to you in governing your design of Ball and Roller bearings. Thirty-two years engineering experience in the making of high precision bearings is at your disposal.
Write or phone for new Catalog giving full particulars
Equitable
EQUITABLE BEARING CO. INC.
Dept. PR
WALDEN, NEW YORK

Bunting, largest producer of Cast Bronze Bearings for Aircraft Engines, has the skill, experience and equipment to make equally fine Cast Bronze Bearings for many other applications. These bearings excell in precision, fine finish and uniform physical and metallurgical qualities. The Bunting Brass & Bronze Company, Toledo 9, Ohio. Warehouses in principal cities.

Bunting

BRONZE BEARINGS ☆ BUSHINGS ☆ PRECISION BRONZE BARS

14

Beat Competition by BEATING RUST

Plan your product to be a winner . . . . in the face of keen future competition . . . . by using Harper Everlasting Fastenings—the fastenings that (1) resist rust and corrosion, (2) stand up in the presence of many acids, alkalies and other tough conditions, (3) add years of service life AT LOW COST, (4) can be removed with ordinary tools and used again and again. Every Harper fastening is made of either brass, copper, naval bronze, silicon bronze, Monel or stainless steel (nothing in common steel).

4360 ITEMS IN STOCK

Harper is known as "Headquarters for Non-Ferrous and Stainless Fastenings" . . . . carries large and complete stocks of 4360 different items and is continually adding others . . . . maintains large stocks of metals in bars, rods, wire, sheet and other basic forms from which special fastenings can be quickly made. Write for 1945 Catalog.

THE H. M. HARPER COMPANY
2610 Fletcher Street, Chicago 18, Illinois

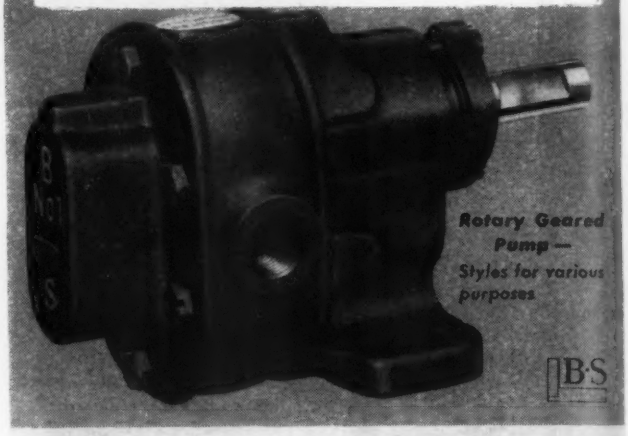
BRANCH OFFICES: New York City • Philadelphia
Los Angeles • Milwaukee • Cincinnati • Houston
Representatives in Principal Cities

HARPER
EVERLASTING FASTENINGS

BRASS • BRONZES • COPPER
MONEL • STAINLESS

PRECISION
in Manufacture brings Outstanding Service

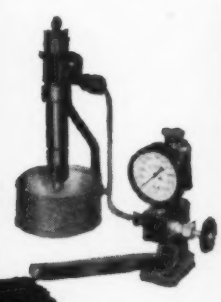
Brown & Sharpe Pumps are precision built in a factory famed for its skill in making precision machines and tools. Such precision manufacture contributes in no small measure to their outstanding performance and reliability. Catalog showing Geared, Vane, Centrifugal and Motor Driven Pumps sent on request. Brown & Sharpe Mfg. Co., Providence 1, R. I., U. S. A.



BROWN & SHARPE PUMPS

ADECO
NOZZLE TESTER

Keeps Diesel Engines Running Efficiently



TESTS FUEL INJECTORS AND HYDRAULIC DEVICES
At Pressures Up To 10,000 p.s.i.

To keep diesel engines operating at peak efficiency, this portable, precision-built Adeco Nozzle Tester is indispensable.

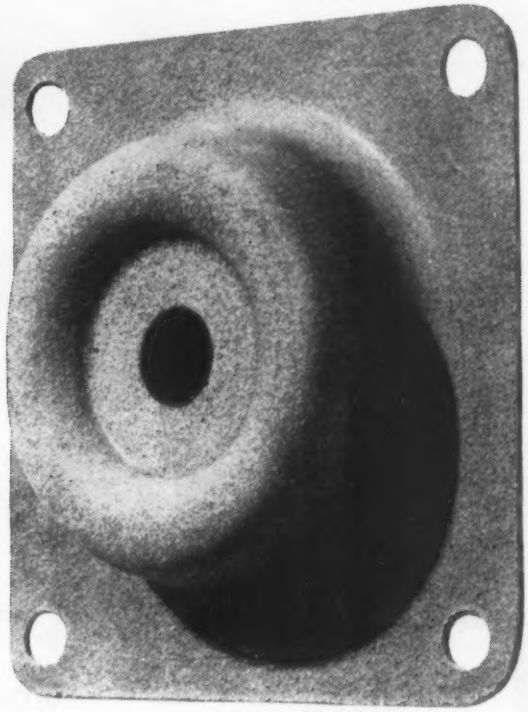
Light in weight yet built for heavy-duty service, it enables any mechanic to make quick, accurate tests on injector opening pressure, spray pattern, etc., and detect stuck needle valves and leakage around valve seats. Tests both large and small injectors, on bench or engine, at pressures up to 10,000 p.s.i. Prevents costly delays and possible damage to engine.

Ideal for testing hydraulic devices.

Write for bulletin on this practical, low-cost unit.

ADECO
AIRCRAFT & DIESEL EQUIPMENT CORP.
4411 NO. RAVENSWOOD AVE.
CHICAGO 40, ILLINOIS

Man's Genius for making things is limited only by the physical properties of the substances used to make them.



MR. ENGINEER . . . here's a very special fulcrum seal

It was custom built for use in a tractor—to seal the opening through which the gear shift lever passes into the transmission case. Its job is to give *positive* protection so that *no* foreign material can invade the transmission. As with all Sirvis products, everything about it is special: it was specially designed from an engineer's specifications; special soft, flexible, high tensile leather was carefully chosen, tanned and treated in accordance with a Sirvis formula developed by Chicago Rawhide engineers; its manufacture was subject to rigid laboratory control; and the finished product is the result of 66 years' experience in processing leather to protect and seal vital machine parts. This seal delivers uniform and constant protection under toughest service conditions.

If mechanical protection is your problem, why not draw upon Chicago Rawhide's unparalleled reservoir of specialized engineering experience? If unusual precision, resilience, long service or resistance to pressure, shock or vibration is demanded in packings, washers, gaskets, couplings or valve discs . . . Chicago Rawhide research can develop the properties you require, and careful production control can assure the most exact processing. For precision performance in protective coverings and seals, specify Sirvis mechanical leather.

sirvis

MECHANICAL LEATHER

A Product of

CHICAGO RAWHIDE MANUFACTURING CO.

1305 Elston Avenue **Chicago 22, Illinois**

New York • Philadelphia • Detroit • Los Angeles • Cleveland • Boston
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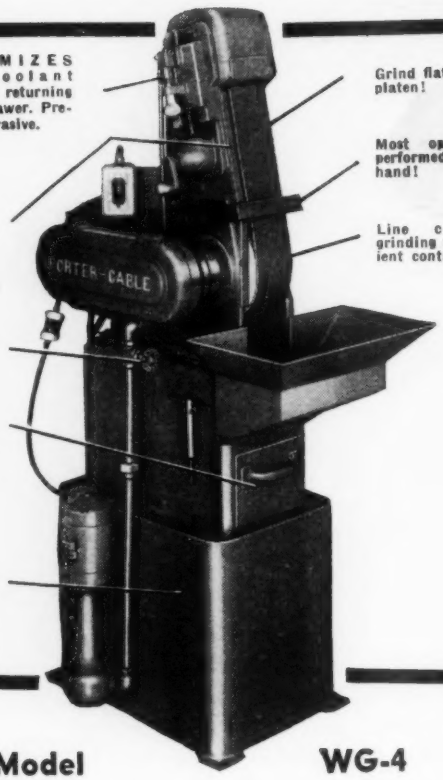
A NEW Wet-Belt SURFACER

for Job Shop, Production Line, Toolrooms . . .



Spray nozzle ATOMIZES coolant — Excess coolant washes waste down returning belt to clean-out drawer. Prevents loading of abrasive.

15° tilt of head —Gives free use of contact roll and full use of coolant on belt.

Coolant supply easily regulated by convenient valve.

Chip or clean-out drawer—traps all grindings and waste.

Recirculating tank forms base of machine. Coolant system is self-contained, self-cleaning, and self-circulating!

Grind flat on the platen!

Most operations performed free-hand!

Line contact grinding on resilient contact roll!

Model WG-4

An all-purpose grinding and surfacing machine!

Runs cooler! Finishes better without warping, heating, distorting, and cracking.

Cuts faster! Cool operation doesn't load belt—machine runs at maximum efficiency.

Dust-free! Employee's health and vital equipment relieved of dangerous, dust-laden air.

Versatile! Machines flats, bevels, generates radii, stands alongside other machine tools for clean-up, burring, or performing grinding operations while other machine completes a cycle.

Saves time! Besides cutting faster—most operations are performed free-hand, saving loading and unloading time for jigs and fixtures.

Write for detailed information! There's a place for this money-saver in every department—from Maintenance to Production

PORTER-CABLE MACHINE CO.

2110-4 N. Saline St., Syracuse 8, N. Y.

AGASTAT

ELECTRO-PNEUMATIC RELAY

COMPACT:
4 IN HIGH
2½ IN DEEP
2½ IN WIDE
WEIGHT:
1½ POUNDS

ELIZABETH A'G'A NEW JERSEY
AMERICAN GAS ACCUMULATOR COMPANY

THE POWER OF A GOOD NAME PLATE

Smartly styled, expertly made name and data plates by Robbins bring positive identification, enhanced appearance and an extra advertising plus to any product. Manufacturers of heavy equipment and luxury utilities alike know the multiple advantages obtained from using Robbins Quality Name Plates . . . metal, plastic or metal with enamel.

Write for free estimates and design suggestions for: Decorative Panels and Trims . . . Name plates . . . Data plates.

The Robbins Company

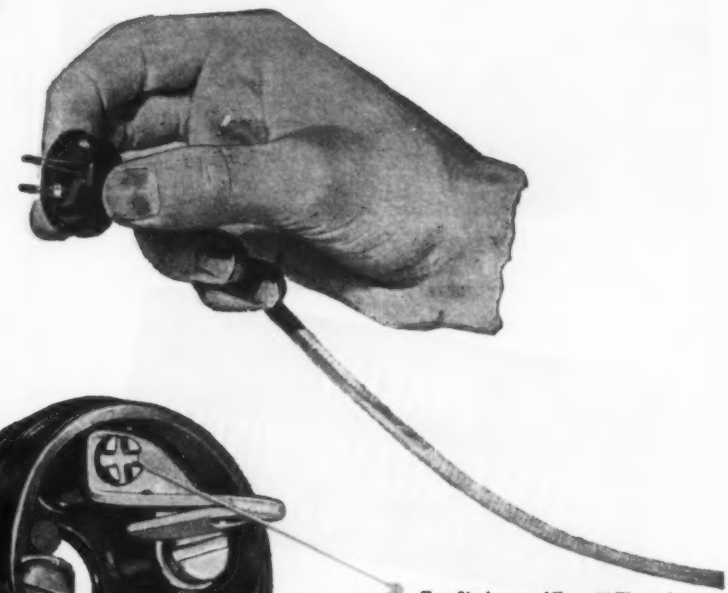
ATTLEBORO, MASSACHUSETTS

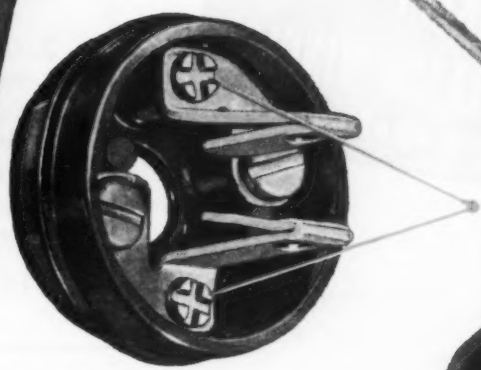
Manufacturers of Emblems and Plaques for over Fifty Years

To learn how a name plate can help your product, send for your copy of "Name Plates by Robbins".

THIS *Plug* PROVES TWO POINTS!

PLASTIC PARTS CAN BE ASSEMBLED AT (1) LOWER COST AND YET HAVE (2) TIGHTER FASTENINGS WHEN ASSEMBLED





Two Shakeproof Type 25 Thread-Cutting Screws are used here to attach the brass terminal to the molded plastic cord plug.

with

SHAKEPROOF TYPE 25 THREAD-CUTTING SCREWS

The unique cutting action of this screw, specially designed for plastic applications, assures freedom from dangerous stresses or strains that are likely to cause fractures in molded plastic parts. Thus, its use permits elimination of both threaded inserts and separate tapping operations with the resulting important savings. Also, because these screws remain in the threads they have cut themselves, a perfect mating fit is assured which results in absolutely tight connections that are able to stand up longer under hard usage. Try this screw on your plastic fastening applications. It will quickly prove its practical advantages.

TEST THE TYPE 25 ON YOUR PRODUCT NOW!

A convenient kit of samples in various sizes and head styles is offered free without obligation. Send for yours today!

ARMY E NAVY

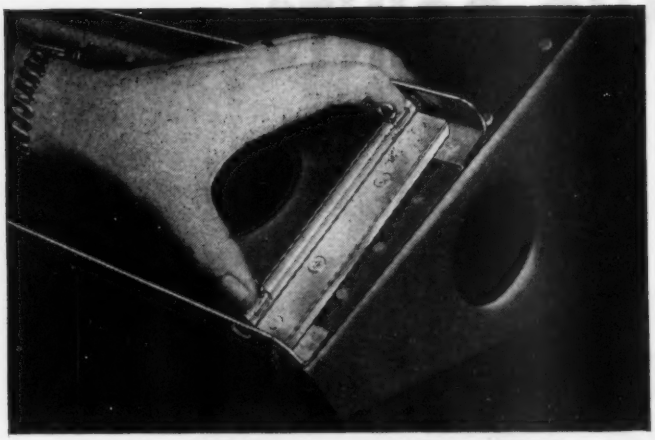
SHAKEPROOF inc.

"Fastening Headquarters"

Distributor of Shakeproof Products Manufactured by ILLINOIS TOOL WORKS
2501 North Keeler Avenue, Chicago 39, Illinois
Plants at Chicago and Elgin, Illinois • In Canada: Canada Illinois Tools, Ltd., Toronto, Ontario

Los Angeles Office
5670 Wilshire Blvd., Los Angeles 36, Calif.

Detroit Office
2895 E. Grand Blvd., Detroit 2, Mich.



Burklyn Locking Type Hinge installed on ammunition box on B-25 Mitchell Bomber.

BURKLYN INSTANT RELEASE HINGES for all these applications

AIRCRAFT

Ammunition chutes—Hatch covers—Internal inspection plates—Emergency bulkheads—Electrical fixture doors—Map and chart tables.

MAINTENANCE

Removable shelving—Work bench attachments Test stand covers—Stock bin fixtures—Emergency repairs—Safety devices—Machine guard accessories

AIRLINES

Seats in cargo planes—Hinged schedule boards—Access doors—Assignment boards—Cargo webbing partitions.

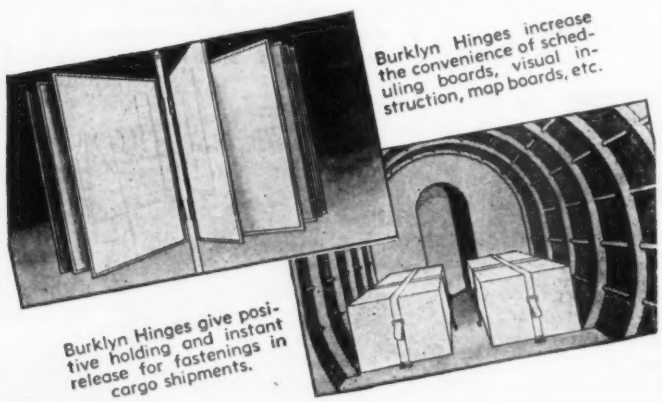
MACHINERY

Hoods and inspection panels—Housings or shelves on electrical equipment—Protective shields, etc.

For complete data and specifications, write

BURKLYN *Company*

3429 Glendale Blvd., Los Angeles 26, Calif.


Burklyn Hinges increase the convenience of scheduling boards, visual instruction, map boards, etc.
Burklyn Hinges give positive holding and instant release for fastenings in cargo shipments.

The New Brush Holder *with the* 4 Features

1. Clamp mounting eliminates close tolerances on stud diameters—and avoids stud marring.
2. Stop screw prevents displacement of brush under shock.
3. Undercut Trigger for spring adjustment maintains position under shock and vibration.
4. Cotter pin and slip stud allow rapid easy spring replacements.

Send for folder with descriptive engineering data.

We manufacture special brush holders for specific requirements; your inquiries are solicited.

PUBLIX METAL PRODUCTS, INC.

100 SIXTH AVENUE, NEW YORK 13, N. Y.

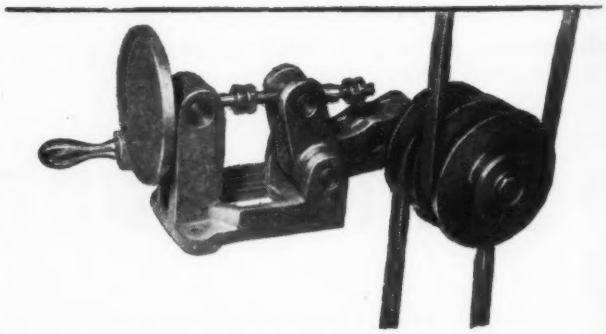
SPEEDMASTER

STEPS UP PRODUCTION

Are your machines set too slow a speed to meet today's production demands? Investigate the Speedmaster, the mode of Variable Speed Control that provides a versatile range of speeds, 6 to 1 ratio.

A turn of the hand wheel changes speeds instantly without work stoppage. Free floating pulley aligns belts automatically and insures long belt life, 3 sizes, 9 different types.

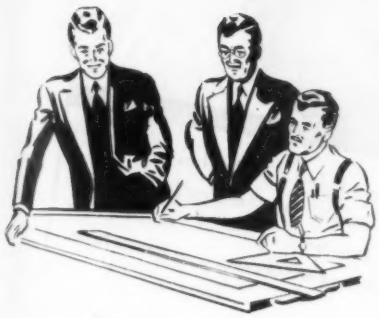
Consult our Engineering Dept. today about adapting Speedmasters to your machines. Ask for interesting new Speedmaster circular.



The DoALL COMPANY

227 N. LAUREL AVE., DES PLAINES, ILL.

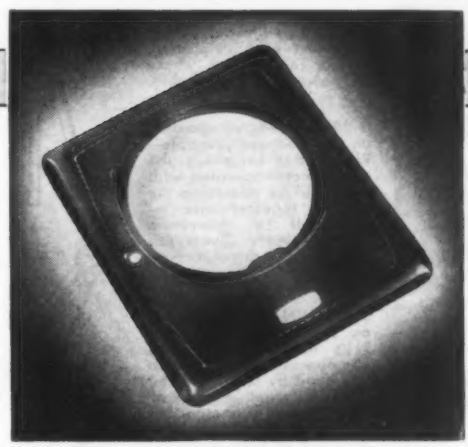
THE CASE OF THE
Meter Case Cover
OR
HOW DAHLSTROM SOLVED ANOTHER "TOUGH ONE"



● **Practically every industry has contributed its own special "know-how" toward the common Victory. DAHLSTROM is proud of its many war contributions resulting in better products, greater efficiency and reduced costs. For postwar, Dahlstrom offers the assistance of its design and engineering staffs in immediate planning with other manufacturers toward a more speedy conversion to Peace. Write today. Metal Specialties Division, *Dahlstrom Metallic Door Company, Jamestown, N. Y.***

COVER FOR RECORDING METER CASE

This cover was originally made of die cast aluminum. Dahlstrom redesigned it as a stamping, using steel when aluminum was a critical material. The present cover has greater strength, will not break when dropped and uses a cheaper material. The design also provides for concealed hinges. Sketch shows underside channel with continuous rubber gasket cover which gives dustproof protection for instruments. Openings are for glass panels and lock.



Material is 16 gauge steel. Size 17 7/16" x 15 1/8" x 7/8" deep. Finished originally in black enamel, now bonderized and with one coat of baked red primer.

ARMY E NAVY

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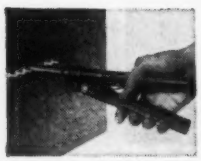
Wide variety in size, weight, operation and pulling head position —these have all been designed into the standard line of Cherry Rivet Guns so that you may have just the right gun to handle your particular Cherry Blind Rivet applications easily and quickly, no matter how unusual or difficult is the location.

G-15RB GUN—operates on from 75 to 125 pounds air pressure—10¾ inches long—weighs approximately four pounds—balanced from the grip for easy one-hand use—especially good for long production runs.

G-10 GUN—hand-operated on the ratchet principle—20½ inches long—weighs approximately 2½ pounds—actuated by bringing the handles together in a series of short strokes—installs any standard Cherry Rivet—excellent for production or repair work where air power is not available.

G-25 GUN—hand-operated on the leverage principle—9½ inches long—weighs nine ounces—operated with one hand by squeezing the handles together once—installs all ⅛" aluminum hollow Cherry Rivets except the pull-through rivet.



G-35 GUN—hand-operated on the ratchet principle—11½ inches long—weighs 23 ounces—actuated with one hand by squeezing the handles together repeatedly—installs any standard Cherry Rivet—handy for cramped or tight spots.

G-20 GUN—operated with any standard wrench—6½ inches long—weighs 14 ounces—specially designed to fit into workman's tool kit—installs any standard Cherry Rivet.

New Manual D-45 *gives quick overall picture of Cherry Blind Rivets and Guns, their many types and uses. Sent free on request. Write to Dept. A-106, Cherry Rivet Co., 231 Winston St., Los Angeles 13, Calif.*

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Cherry Rivet *Company*

LOS ANGELES, CALIFORNIA

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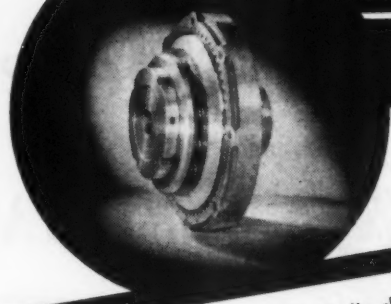
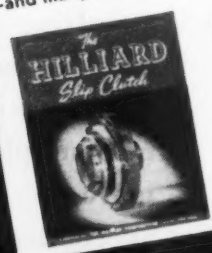


A reliable series of spring-loaded slip clutches and couplings made in a variety of types. Outstanding for—reeling and winding operations—tension drag brakes—limiting torque—preventing overloads and shocks—starting heavy loads—and many other uses.



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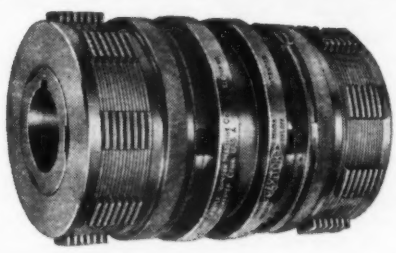

machine user need tolerate bulky, complicated old-time clutch, brake or reversing hook-ups when these functions are so well handled by the COMPACT, SIMPLE, TROUBLE - ELIMINATING MAXITORQ DISC CLUTCH. Just look at the list of real "User Benefits" . . . realize that MAXITORQS cost no more and often less than less satisfactory units. Then put in a call or write to our engineering department for help on your problems. Modestly we say . . . we know as much or more about clutches as anyone else in the field.

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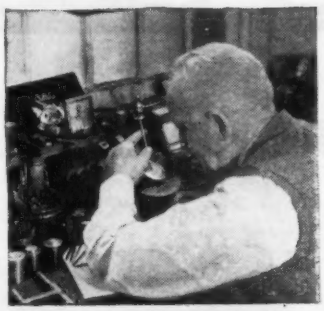

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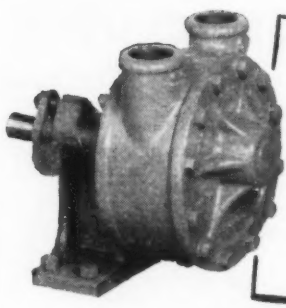

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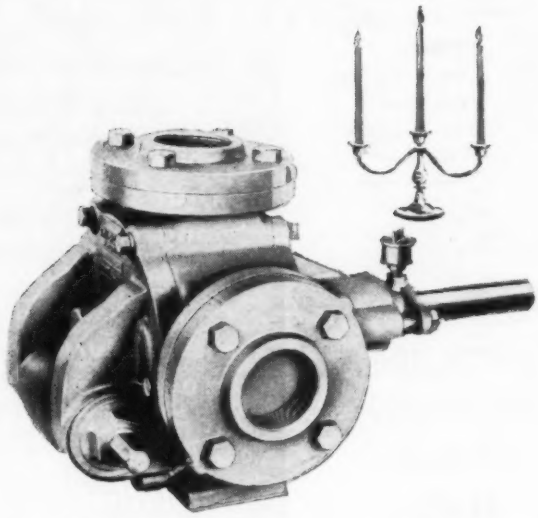

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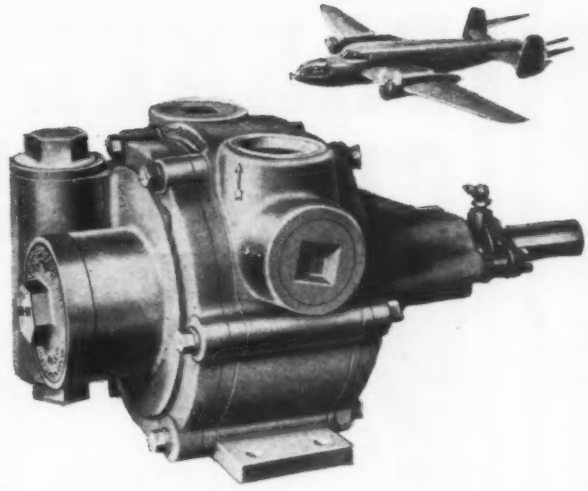
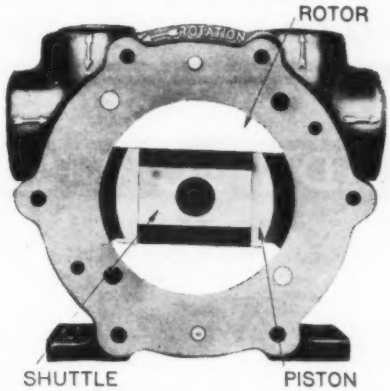
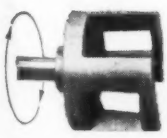
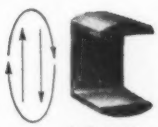


Yale & Towne TRI-ROTOR Turbo-Supercharger Lubricating Oil Pump for stratosphere flights.





A ROTOR



A PISTON

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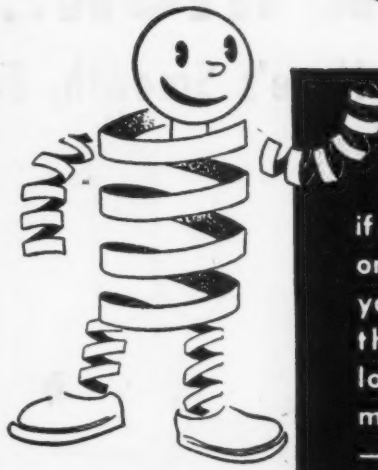

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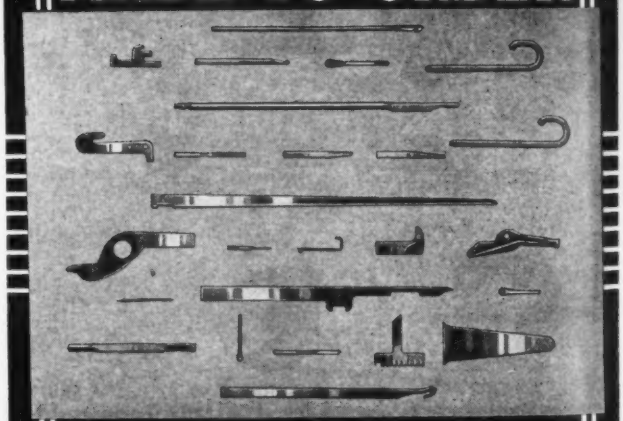

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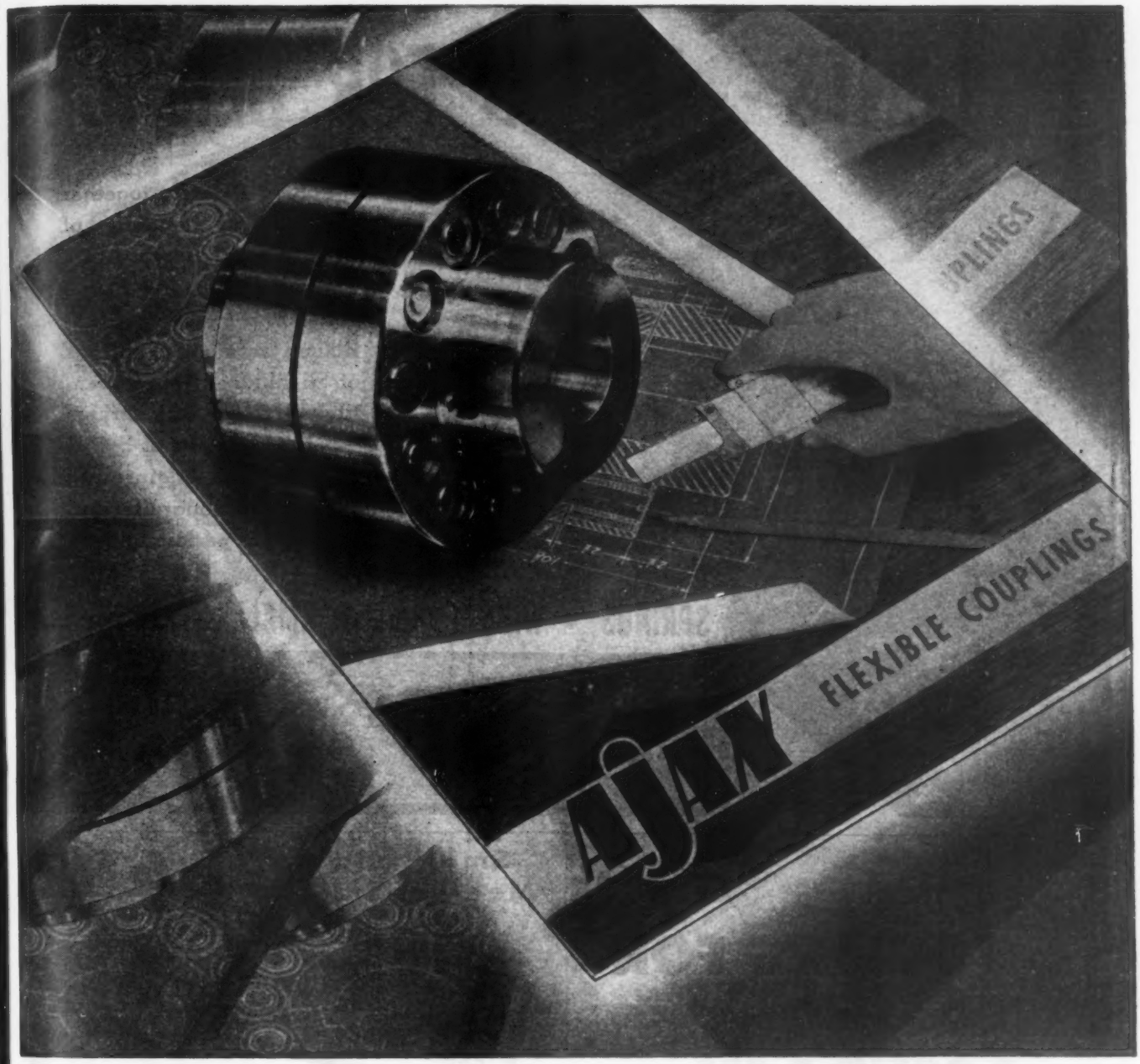

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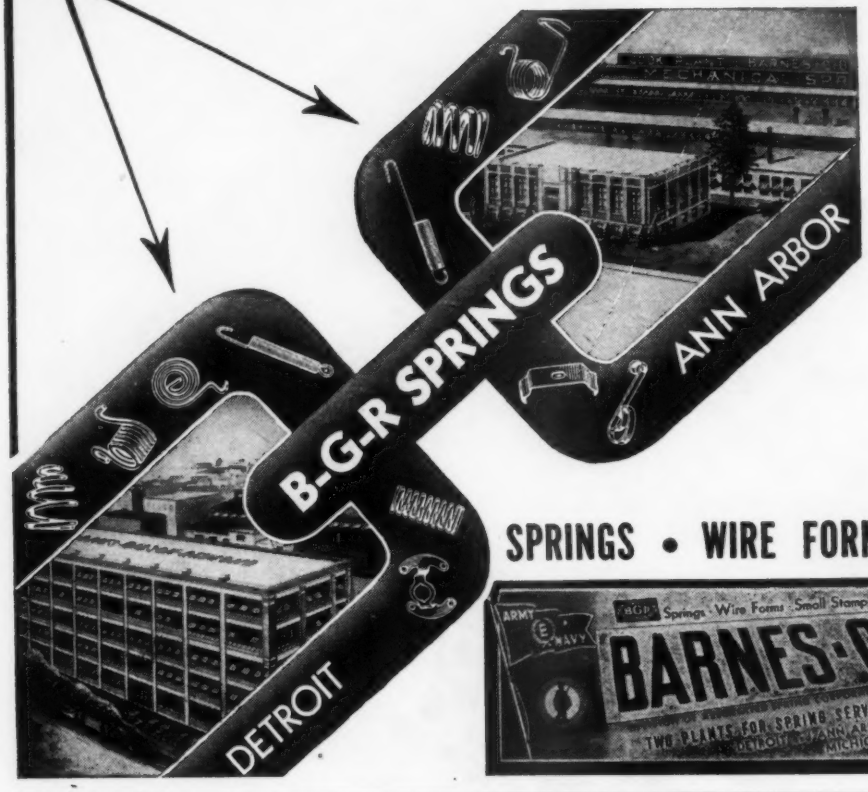

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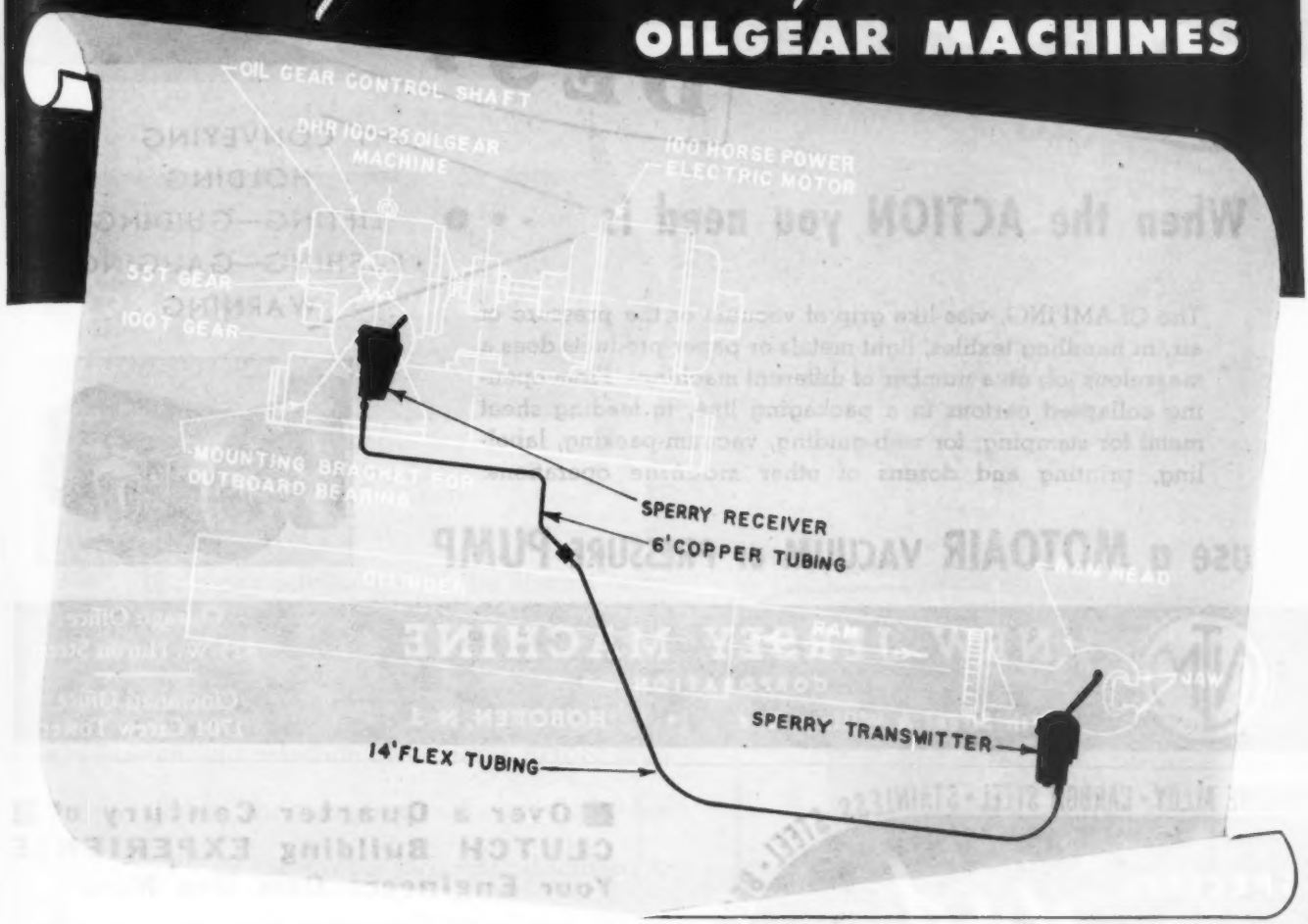
SPERRY HYDRAULIC CONTROLS provide *Precision Operation* of OILGEAR MACHINES



SPERRY HYDRAULIC CONTROLS are used by the Aluminum Company of America's Massena Plant on a 250,000 lb. Rod and Bar Stretching Machine, as shown above. A Transmitter mounted on the moving Ram Head remains constantly at the operator's hand, allowing him instant control of the stationary Receiver. The motion of the Receiver is transmitted through a gear and pinion to the rotary pilot valve which, in turn, controls the pump stroke of the Oilgear Machine.

APPLICATION: Manual control of speed and direction of motion of Ram Head on Alcoa's 250,000 lb. Rod and Bar Stretching Machine.

PROBLEM: Original installation of mechanical controls presented following difficulties:

a. Control set-up limited operator's vision.
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c. Frequent and expensive maintenance due to complexity of mechanical controls.

SOLUTION: Alcoa changed to Sperry Hydraulic Controls with the following results:

a. Hydraulic control sensitivity provides precise control.
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Sperry's Hydraulic Controls minimize design problems by utilizing a single connected tube that can be bent around corners and pillars, and installed through walls and other obstacles, thus reducing installation and maintenance costs.

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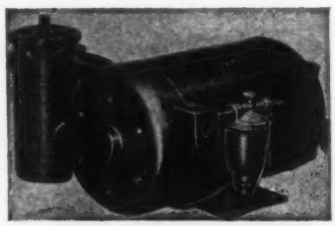

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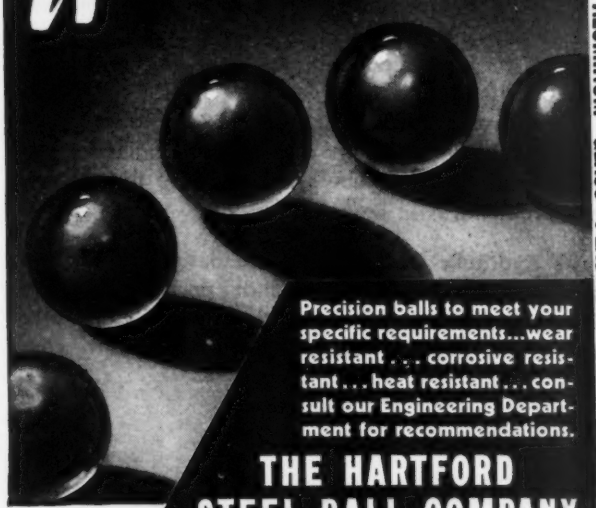

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It shows typical installations of ROCKFORD CLUTCHES and POWER TAKE-OFFS Contains diagrams of unique applications. Furnishes capacity tables, dimensions and complete specifications. Every production engineer will find help in this handy bulletin, when planning postwar products.

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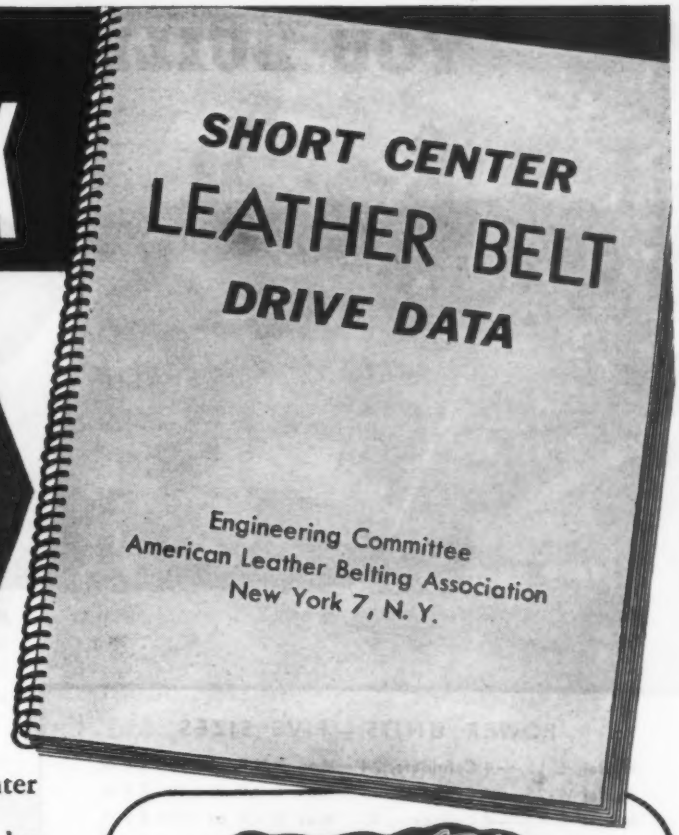
A REAL DESIGN ASSET



The many advantages of the Short Center Leather Belt Drive are known and accepted by machine designers. Yet the full details concerning application and selection have never before been fully available. The many factors that may influence the selection of the proper drive are discussed in this book. In it are pages of Belt Selection Tables using different pulley combinations on drives rang ing from 1 to 150 hp.

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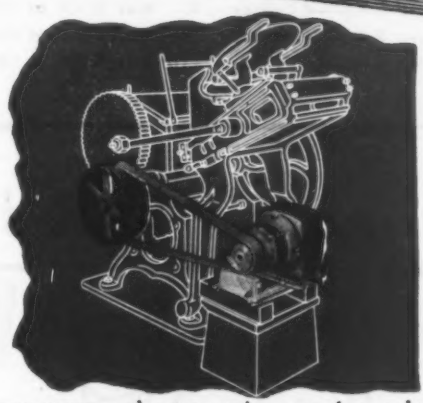
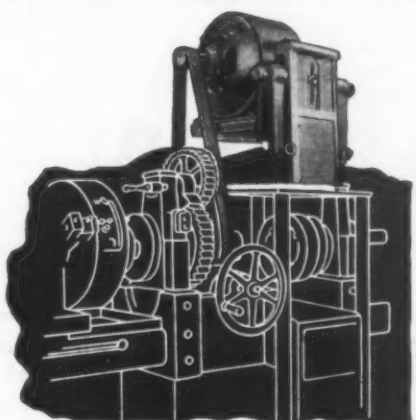


Compactness and space saving are always desirable. The pivoted motor base assures uniform tension in the leather belt regardless of load changes.



Short center drive applications can be placed up out of the way as on this horizontal boring mill. Belt life is increased and power is saved.

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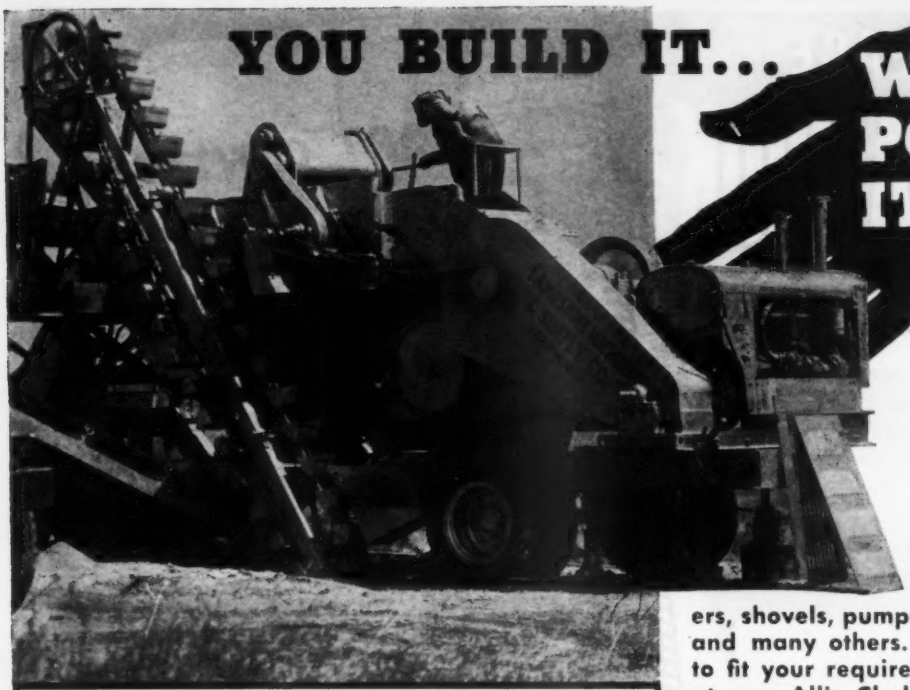

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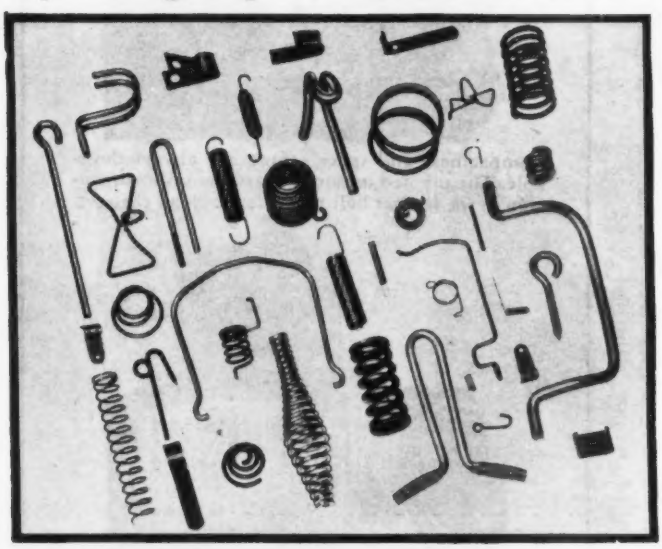

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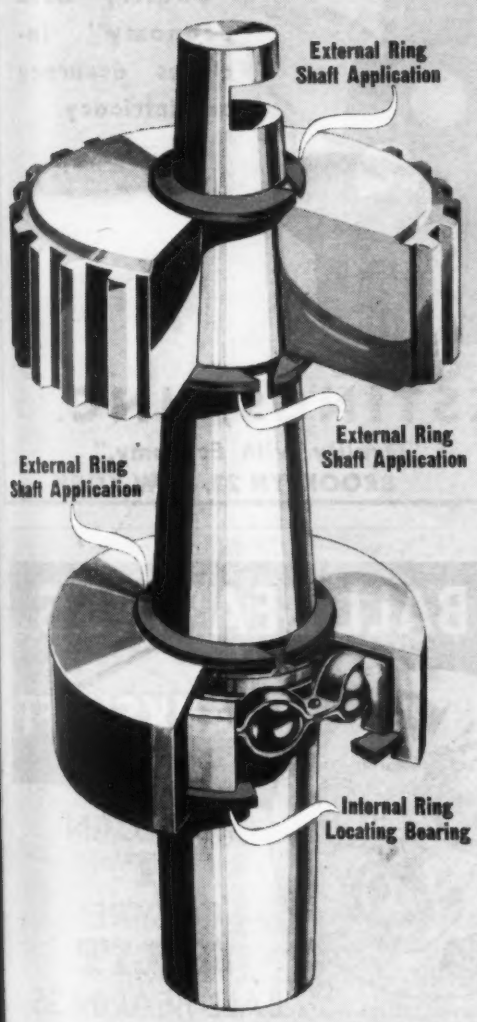

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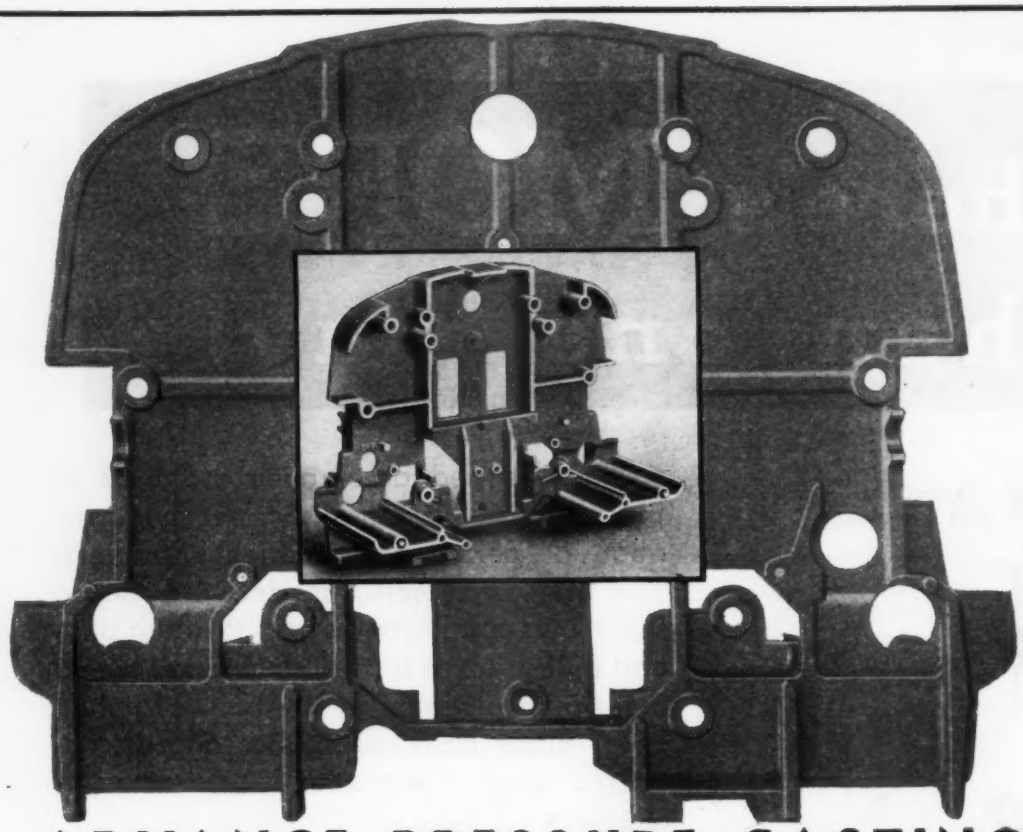

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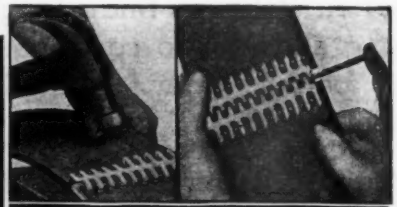

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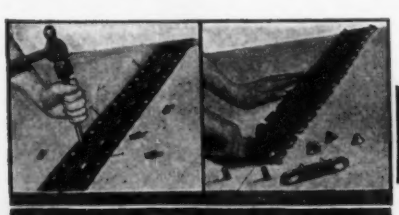

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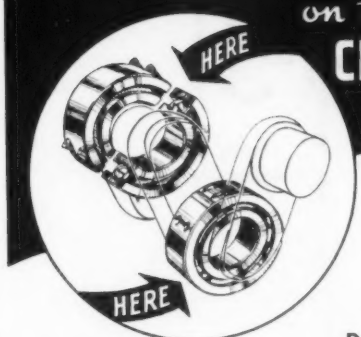

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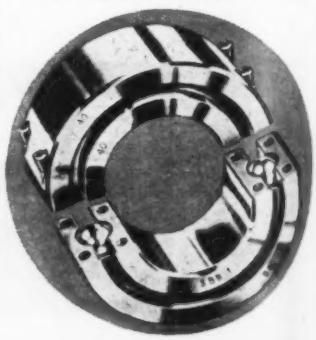

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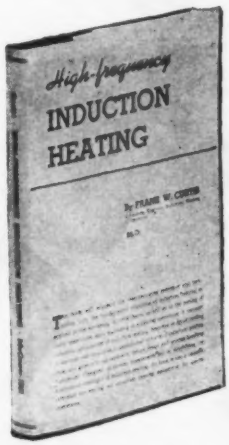

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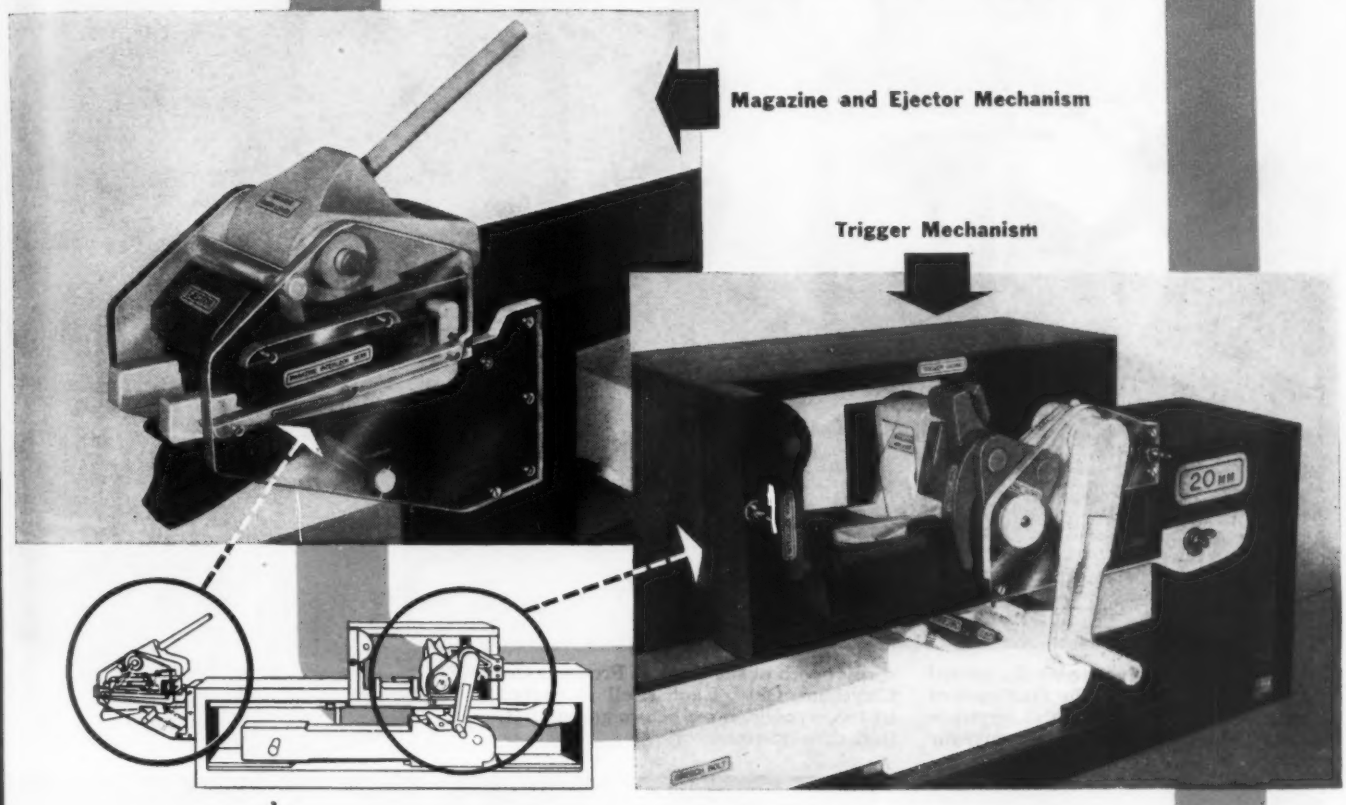

IF you have a plastics molding problem, place it in the hands of specialists. Erie Resistor, pioneer custom injection molder of America, has the experience and facilities to meet your most exacting specifications. An interesting example is the "twice size" model of the 20 millimeter Naval instruction gun shown in illustration.

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BATTLE DRESS is given to vitally needed 81 MM mortar shells! The final coat of Sherwin-Williams Olive Drab Lacquer is speedily applied in a special conveyor spray booth at the Enamel Products Co. Cleveland, Ohio. Each shell is coated in ten seconds, dries before going 25 ft. (less than one minute)!

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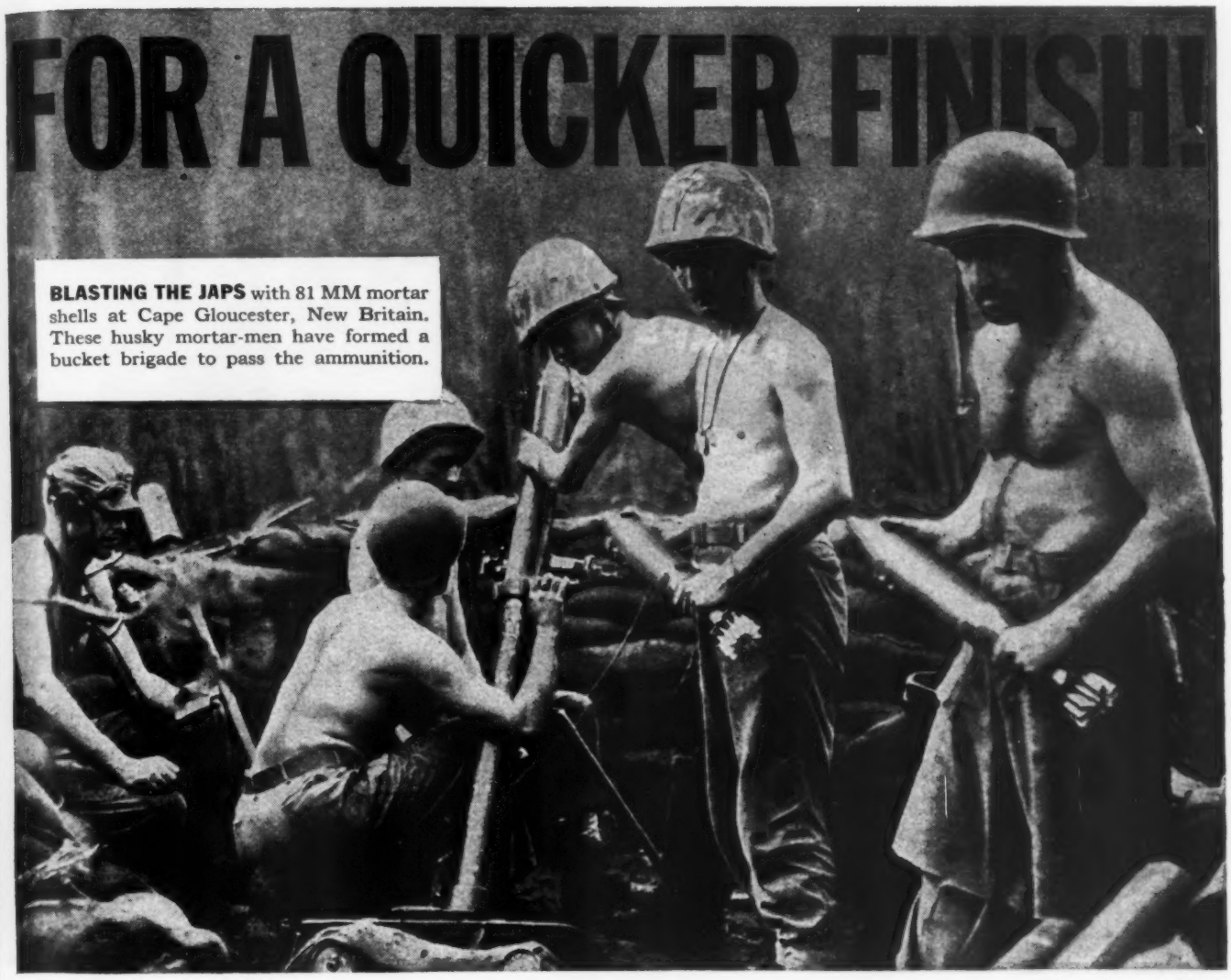

BLASTING THE JAPS with 81 MM mortar shells at Cape Gloucester, New Britain. These husky mortar-men have formed a bucket brigade to pass the ammunition.

Picture by Acme Photo

SHERWIN-WILLIAMS helps The Enamel Products Co.

Speed 81 MM Shells on Their Way!

The deadly accuracy and blasting power of 81 MM mortar fire has proven extremely effective in the close-quarter fighting U.S. troops are meeting on all fronts.

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This experience of The Enamel Products Company, Cleveland, Ohio, is but one example of the cooperation that the Sherwin-Williams Co. is willing and able to offer. Perhaps we can help *you*? Write the Sherwin-Williams Co., Cleveland 1, Ohio.

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GRAPHITAR BEARINGS
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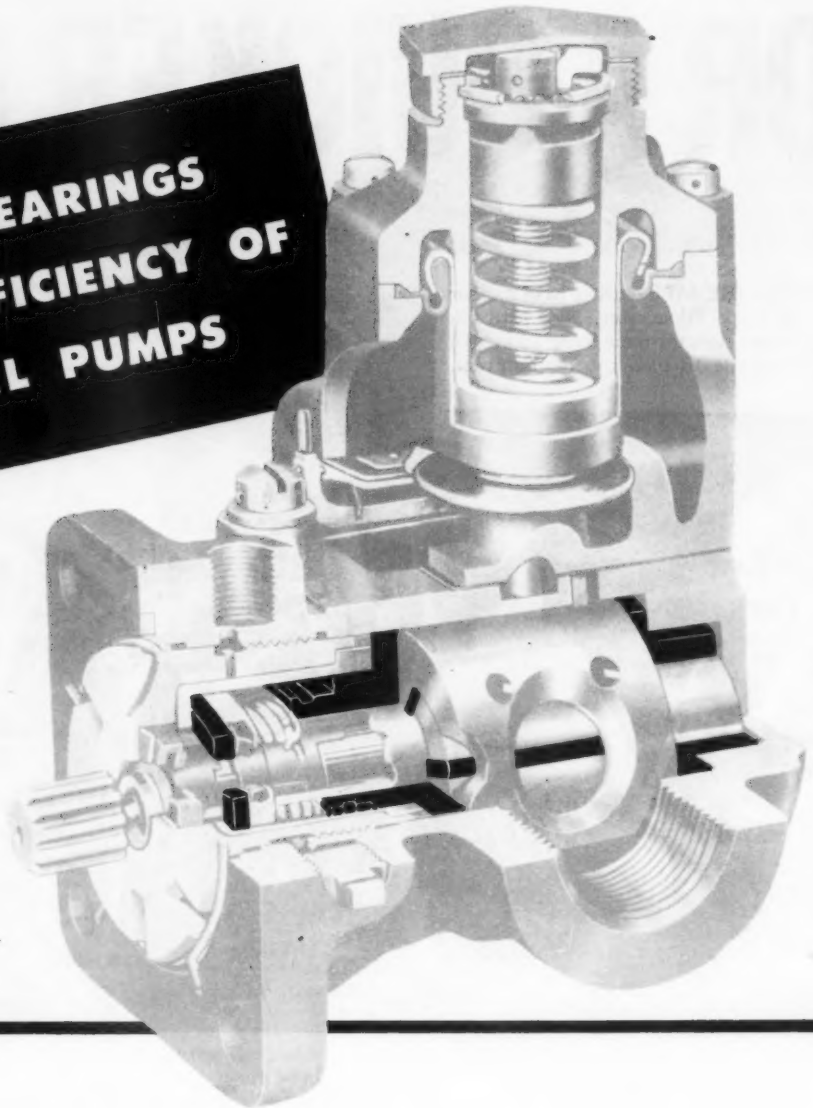

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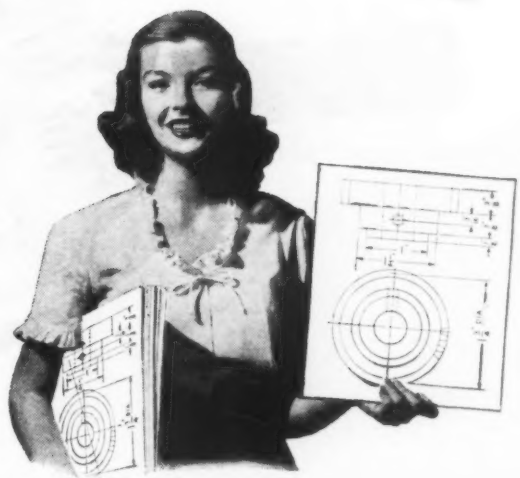

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Advertisement APRIL, 1945

COPPER ALLOY BULLETIN

REPORTING NEWS AND TECHNICAL DEVELOPMENTS OF COPPER AND COPPER-BASE ALLOYS

Prepared Each Month by the Bridgeport Brass Co. "Bridgeport" *Headquarters for BRASS, BRONZE and COPPER*

Profits vs. Spoilage

Imparting Special Properties to Metals Designed for Fabrication Purposes

What are some of the greatest enemies of profits? Among the most obvious are spoilage and extra operation costs. If these can be reduced substantially, profits will quickly rise.

First of all, let us carefully analyze the causes of spoilage and extra operations. It is true that fabricated articles may be rejected for mechanical defects resulting from careless workmanship. We shall not go into this phase here but shall consider the problem of spoilage and high costs from the metal specifications angle only. When a piece of tubing splits during a flanging operation or when wire shears in a severe heading operation, is the metal too hard? Should a more ductile alloy have been used? If costs are too high is it because it was necessary to use more operations than shown on the estimate when the job was accepted? Is trouble encountered in machining? Are polishing costs excessive because the metal had an "orange peel" surface? Are finished articles rejected because they cracked or wore out too rapidly in service?

Low fabrication costs depend largely upon mass production methods involving few but severe operations and the minimum of labor. It is obvious, therefore, that the material to be fabricated must meet special requirements and be very uniform in properties and in gauge dimensions. This means that every job must be carefully analyzed periodically for both metal specification and manufacturing methods. Improvements in materials and production methods resulting from research may reduce costs if applied.

Much progress has been made in recent years in the manufacture of copper base alloys. Fabricators recognize that physical properties depend largely upon manipulation—that is, whether the material is in the cast, extruded, rolled, drawn or annealed condition. Properties such as ductility, toughness, springiness, strength and stiffness, are controlled either by the temperature of anneal or by the amount of reduction by rolling or drawing following the last anneal. Machinability, corrosion resistance, hot and cold workability are controlled largely by modifying the basic compositions and by adding small quantities of additional metals. To meet exacting specifications and to control uniformity, Bridgeport leans heavily on the Laboratory with its scientific control and research. Realizing that metallurgy is a highly specialized science, customers are invited to present their metal problem for solution.

Importance of Annealing or Softening By Heating at Elevated Temperatures

Work-hardened metal can be softened by annealing; that is by raising its temperature high enough to affect its structure. Different degrees of softness are obtained by controlling the temperature which the metal attains in the furnace and the length of time it is exposed to the heat. Under the microscope a piece of annealed metal that has been prepared by polishing and etching for microscopic examination appears to be made up of irregularly shaped crystals or grains. The higher the annealing temperature, the larger the crystals and the softer the metal, and the greater its elongation or stretch. Grain structure also affects the tensile strength; the smaller the grains the higher the strength and hardness.

When thin gauge strip metal is formed or stretched, the size of the grain affects the surface appearance. A coarse grain imparts an "orange peel" surface. A fine grain gives a smooth surface which requires less polishing when a highly buffed finish is required. Space does not permit too much detail regarding the effect of grain size on cupping, drawing and upsetting operations. We know that the grain structure has a profound influence on breakage and finishing costs. For this reason the mill considers the annealing operation one of the most important in metal processing and therefore carries a large investment in special furnaces and temperature and atmospheric control equipment. In many instances the fabricator must also anneal parts that require more than one cold working operation for completion. The annealing operations performed by him are just as important as those performed by the mill.

The degree of anneal should not be designated by such general terms as "light", "semi", "soft", or "dead soft." To avoid misunderstanding, A.S.T.M. specifications express the degree of anneal in specific grain sizes with maximum and minimum limitations. A.S.T.M. specifications also include chemical compositions, physical properties and dimensional tolerances.

Importance of Temper or Degree of Hardness

Since stiffness, hardness, and degree of tensile strength of wrought metals depend upon the amount of cold working which the metal receives after the last anneal it may range in tensile strength from 38,000 p.s.i. in the annealed condition and from 80,000 to 100,000 pounds p.s.i. in its hard condition depending upon the amount of cold working and the composition of the alloy. In the manufacture of various articles the strength and degree of stiffness of the metal is of the utmost importance. For this reason the fabricator should supply definite specifications which indicate the temper or degree of hardness of sheet, wire, rod and tubing, and thus avoid costly misunderstandings.

Temper of Flat Rolled Products

In standard mill practice, the reduction by rolling is figured on the basis of thickness only because the metal does not widen very much during the rolling operation. The degree of rolling is expressed in Brown and Sharpe gauge numbers which were developed many years ago and which have a definite relationship to each other. For example, in the Brown and Sharpe gauge system the gauges are reduced by 50% every six numbers as shown below:

No. 2 B&S is .2576 inch
No. 8 B&S is .1285 inch
No. 14 B&S is .06408 inch

The following standards for hard rolled metals have been universally adopted for strip and sheet by the brass industry as given in A.S.T.M. specifications:

Temper	*Rolled B&S*	*Percent Reduction In Thickness*
Quarter hard	1 B&S no. hard	10.95%
Half hard	2 B&S nos. hard	20.7 %
Three quarter hard	3 B&S nos. hard	29.4 %
Hard	4 B&S nos. hard	37.1 %
Extra hard	6 B&S nos. hard	50.15%
Spring	8 B&S nos. hard	60.5 %
Extra spring	10 B&S nos. hard	68.65%

Suppose you wished to obtain metal .010" thick, "hard" temper. Metal .010" thick corresponds to 30 B&S. The mill takes 4 nos. B&S thicker than No. 30, namely, No. 26 (.0159), anneals it, then rolls it to No. 30 without intermediate anneal, leaving it in its rolled condition at this finishing thickness. For uniformity of temper, the grain size of the metal in the annealed condition before the final rolling must be controlled.

(Continued on page 2, column 1)

Profits vs. Spoilage

(Continued from page 1)

Temper of Drawn Wire

When drawing wire through a die the percent reduction is based on the difference in cross-sectional areas. Here also the B & S gauge numbers are used as well as percent reduction to indicate the temper of drawn material.

Temper	Nominal Reduction B & S Gauge Nos.	Percent Reduction in Cross-Sectional Area
Eighth hard	½	10.9%
Quarter hard	1	20.7%
Half hard	2	37.1%
Three quarter hard	3	50.0%
Hard	4	60.5%
Extra hard	6	75.0%
Spring	8	84.4%

The trade uses other designations for special tempers such as "rivet temper" (usually between 8% to 20% reduction in cross sectional area), machine screw temper (between 10% and 20% reduction) and wood screw temper (between 15% and 37% reduction). To play safe the manufacturer of screws and rivets should try out several samples of wire of different tempers before he determines on the one which best serves his needs.

Temper of Rod

The tempers on rod do not necessarily follow the percent of reduction used for wire but depends upon the physical properties required. To avoid misunderstandings the mill prefers to have the tempers of rod and wire expressed in "percent reduction in area by cold working." Free turning brass rod, however is generally furnished in a standard temper that has been developed for the various sizes after practical experimentation. Special screw machine items made from free turning rod which must be roll threaded, knurled, or swaged require special tempers depending on the severity of the operations.

Temper for Drawn Tubing

When supplying cold drawn tubing the temper is based upon the difference in cross-sectional areas before and after drawing. The commonly accepted terms for designating temper of tubing are even less definite than for rod and wire. "Light drawn", generally indicates a percentage reduction in area, by cold working, of 10% to 25% and "hard drawn" a percentage reduction in area, by cold working, of over 25% after the last anneal.

The term "percent reduction in area" as applied to tubing is somewhat complicated. A simple explanation is that this term "percentage reduction in area" is the percentage difference in cross-sectional areas of the tube before and after drawing. For example, an annealed tube 1" O.D. x .065" wall has a cross-sectional area of .191 square inches. When drawn to 13/16" O.D. x .049, its cross-sectional area is .117 square inches, resulting in a percentage reduction in area by cold working of 39.0%.

Tubing for screw machine work without any subsequent cold working operations can be drawn as hard as possible with the reduction in area depending upon the size. On the other hand, tubing for screw machine work which has to take some light cold working operation after machining would be furnished in a "light drawn" temper, the reduction depending upon the severity of the operation. Also, a tube for bending would be furnished in a temper indicated as light drawn, the degree of reduction depending upon the amount of bending. Orders calling for "hard" temper, "half-hard", and occasionally "quarter hard" do not indicate actual requirements. Consequently, full information should be furnished regarding the actual use of the tubing so that the proper temper can be supplied. The term "percentage reduction in area" by cold working is more definite and less subject to error.

In closing, it should be emphasized that proper attention to the subject of correct metal specifications will pay for itself many times over in eliminating costly mistakes and misunderstandings. Valuable time will be saved for both the fabricator and the mill. Our laboratory will be glad to help in keeping metal specifications clear and accurate.

Duronze Manual Available

This manual containing tables, charts and other physical data about Bridgeport's DURONZE ALLOYS is available for engineers and designers. Write on company stationery for a free copy of this 80-page technical booklet.

NEW DEVELOPMENTS

This column lists items manufactured or developed by many different sources None of these items has been tested or is endorsed by the Bridgeport Brass Company. We will gladly refer readers to the manufacturer or other sources for further information.

Metal Coloring for ferrous and non-ferrous metals is claimed to be achieved by a process of chemical immersion. A lengthy range of colors is said to be obtained in iridescent or matte finishes and that many of the coloring baths increase the corrosion resistance of the metal. The coloring materials are furnished in either salt or solution form. **No. 599**

Boring and Milling Machine is reported to bore, turn, and mill on same set-up. The machine was designed for jobs where turning, boring, and milling had to be done on the same work piece and where it was essential to save time. **No. 600**

A Self-Sealing Coupling is said to make possible the disconnection and reconnection of hydraulic or other lines without loss of fluid or inclusion of air. Service experience has shown that there is practically no restriction when coupling is completely coupled, and consequently can be successfully installed in suction lines. **No. 601**

A Magnetic Automatic Coolant Separator has been developed for installation on honing machines, grinding machines, and other equipment. It is stated that the new separator uses permanent magnets for moving metal and abrasive particles from honing coolants having a non-soluble base. **No. 602**

An X-Ray Spectrometer is said to permit quantitative determination by unskilled operators of the compositions of crystalline mixtures without photography, measurement, or computation. The method not only quantitatively identifies chemical substances, such as metals formed by powder metallurgy, alloys for phase determination, ceramics and refractories, boiler scale, and paint pigments, but also their state of combination in a given material. The instrument is said to make routine measurements of particle size in the range from colloidal to 0.1 micron. **No. 603**

A New Moisture Meter is claimed suitable for rapid moisture determination in powdered and granular materials such as soaps and molding powders. Of electronic type, it is said to be simple in construction, yet extremely sensitive. **No. 604**

PRODUCTS OF THE BRIDGEPORT BRASS COMPANY

Executive Offices: BRIDGEPORT 2, CONN.—Branch Offices and Warehouses in Principal Cities

SHEETS, ROLLS, STRIPS—*Brass, bronze, copper, Duronze,* for stamping, deep drawing, forming and spinning.

CONDENSER, HEAT EXCHANGER, SUGAR TUBES—For steam surface condensers, heat exchangers, oil refineries, and process industries.

PHONO-ELECTRIC* ALLOYS—High-strength bronze trolley, messenger wire and cable.

WELDING ROD—For repairing cast iron and steel, fabricating silicon bronze tanks.

LEDRITE* ROD—For making automatic screw machine products.

BRASS, BRONZE, DURONZE WIRE—For cap and machine screws, wood screws, rivets, bolts, nuts.

DURONZE ALLOYS—High-strength silicon bronzes for corrosion-resistant connectors, marine hardware: *hot rolled sheets* for tanks, boilers, heaters, flues, ducts, flashings.

BRASS "Bridgeport" COPPER

Established 1865

COPPER WATER TUBE.

FABRICATING SERVICE DEPT.—Engineering staff.

BRASS AND COPPER PIPE

Note: Bridgeport products are supplied in accordance with existing priority regulations.

*Trade name.

BRIDGEPORT **BRASS**

You see above some typical post-war product parts—samples of plastic moldings—one in Saran—two with metal inserts in Styrene—others in different materials—for forward-looking Amos customers. The molds have been Amos-engineered and built—ready for fast production, when materials are available.

Amos facilities are being greatly expanded for doing plastic molding jobs—*and doing them right*—the way customers want them. A new plant is about to be completed and equipped for compression as well as injection molding. Then, Amos can take care of more customers who want their post-war plastic molding jobs *done right, from engineering to finishing.*

Now's the time to get your jobs ready to go. Just send us your drawings or write us what you have in mind to be molded in plastics.

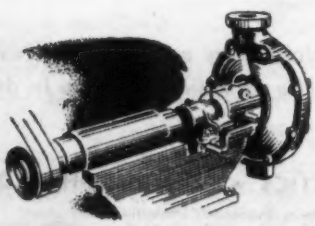
AMOS MOLDED PLASTICS • EDINBURGH, INDIANA
Division of Amos-Thompson Corporation

Amos
MOLDED PLASTICS...

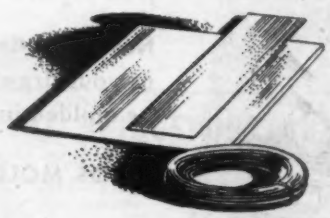
CUSTOM *Molders of*
Plastic Parts and Products
INJECTION • COMPRESSION

For the Tough Jobs use H

Properties of HAYNES STELLITE Alloys	Average Tensile Strength, psi	Average Hardness, Rockwell	Melting Point, Deg. F	Can be Forged	Can be Rolled
HAYNES STELLITE Cobalt-Base Alloys					
1	47,000	C54	2,282	No	No
6 Cast	105,000	C40	2,327	Yes	Yes
Rolled	130,000	C40 to C46			
12	76,000	C48	2,306	No	No
Star J-Metal	65,000	C61	2,318	No	No
98M2	63,000	C62	2,250	No	No
HASTELLOY Nickel-Base Alloys					
B Cast	80,000	B96	2,440	Yes	Yes
Rolled	135,000	B98			
C Cast	76,000	B93	2,350	No	Yes
Rolled	120,000	B90			
D Cast	38,000	C53	2,040	No	No
HAYSTELLITE Tungsten-Base Alloys	—	Between 9 and 10 Moh's Scale	—	No	No
HASCROME Iron-Base Rod	40,000	C40-50 after peening	—	Yes	Yes



Castings . . . A wide range of castings can be supplied in:
HAYNES STELLITE Alloys 6, Star J-Metal, 98M2, 93
HASTELLOY Alloys B, C, D
HAYSTELLITE Tungsten-Base Alloys



Rolled Forms . . . Sheets and plates are made from:
HAYNES STELLITE Alloy 6
HASTELLOY Alloys B, C
Hot-rolled bars are supplied in:
HASTELLOY Alloy B

Welding Rods . . . for applying a wear- and corrosion-resistant alloy coating to other metals:
HAYNES STELLITE Alloys 1, 6, 12
HASTELLOY Alloys B, C, D
HAYSTELLITE Alloys
HASCROME Rod

HAYNES STELLITE Alloys

Resistance to Corrosion		
Oxidation at High Temp.	Sulphuric Acid	Hydrochloric Acid
Excellent	Fair	Fair
Excellent	Fair	Fair
Excellent	Fair	Fair
Excellent	Fair	Fair
Excellent	Fair	Fair
Fair	Good	Excellent
Excellent	Good	Good
Fair	Excellent	Fair
—	—	—
Fair	—	—

Available in a wide range of properties and forms to resist wear, corrosion, and heat . . .

HAYNES STELLITE alloys are specially made to meet the requirements of industry's most difficult applications. They are hard, tough, and heat-resistant and are used for those parts of equipment and machines that are most subject to wear and corrosion. The chart at the left describes some of these alloys and their significant properties. Sketched below are some of the forms in which they can be furnished.

For further information, write for the booklet, "Properties of HAYNES STELLITE Alloys."

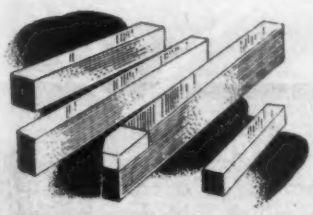
HAYNES STELLITE COMPANY

Unit of Union Carbide and Carbon Corporation

UCC

General Office and Works, Kokomo, Ind.

Chicago—Cleveland—Detroit—Houston—Los Angeles—New York—San Francisco—Tulsa



Metal-Cutting Tools . . . made from HAYNES STELLITE Alloys, known for their red hardness. These tools take heavy cuts at high speeds and coarse feeds—with long life between grinds:

HAYNES STELLITE Star J-Metal
HAYNES STELLITE Alloy 98M2

HAYNES STELLITE TRADE-MARK

HAYNES STELLITE . . . HASTELLOY . . . HAYSTELLITE . . . HASCROME are registered trade-marks of Haynes Stellite Company.

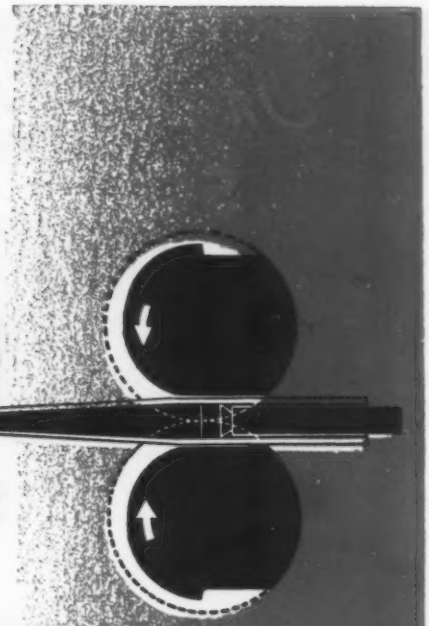
BUY UNITED STATES WAR BONDS AND STAMPS

Rockrite rolled

THE ROCKRITE PROCESS

The Rockrite process is a complete departure from the familiar cold-drawing method of sizing seamless tubes. It is the modern process whereby semi-circular, grooved dies rock back and forth over the tube, compressing the metal against a mandrel which controls the inside diameter.

to close tolerances



with these Production Boosting Money Saving Results

Ring-shaped or cylindrical parts can be machined from Rockrite tubing faster and at lower cost than is possible with ordinary tubing or bar stock, because —

Fast reaming or broaching replaces slow drilling or time-wasting boring of inside surfaces.

Production of finished parts by automatic screw-machines is usually increased subtantially, by avoiding the bottleneck of delayed operations.

High cutting speeds—100 to 117 surface feet per minute—are easily realized without shortening tool life.

One-operation forming-tool finishing of outside surfaces is frequently possible.

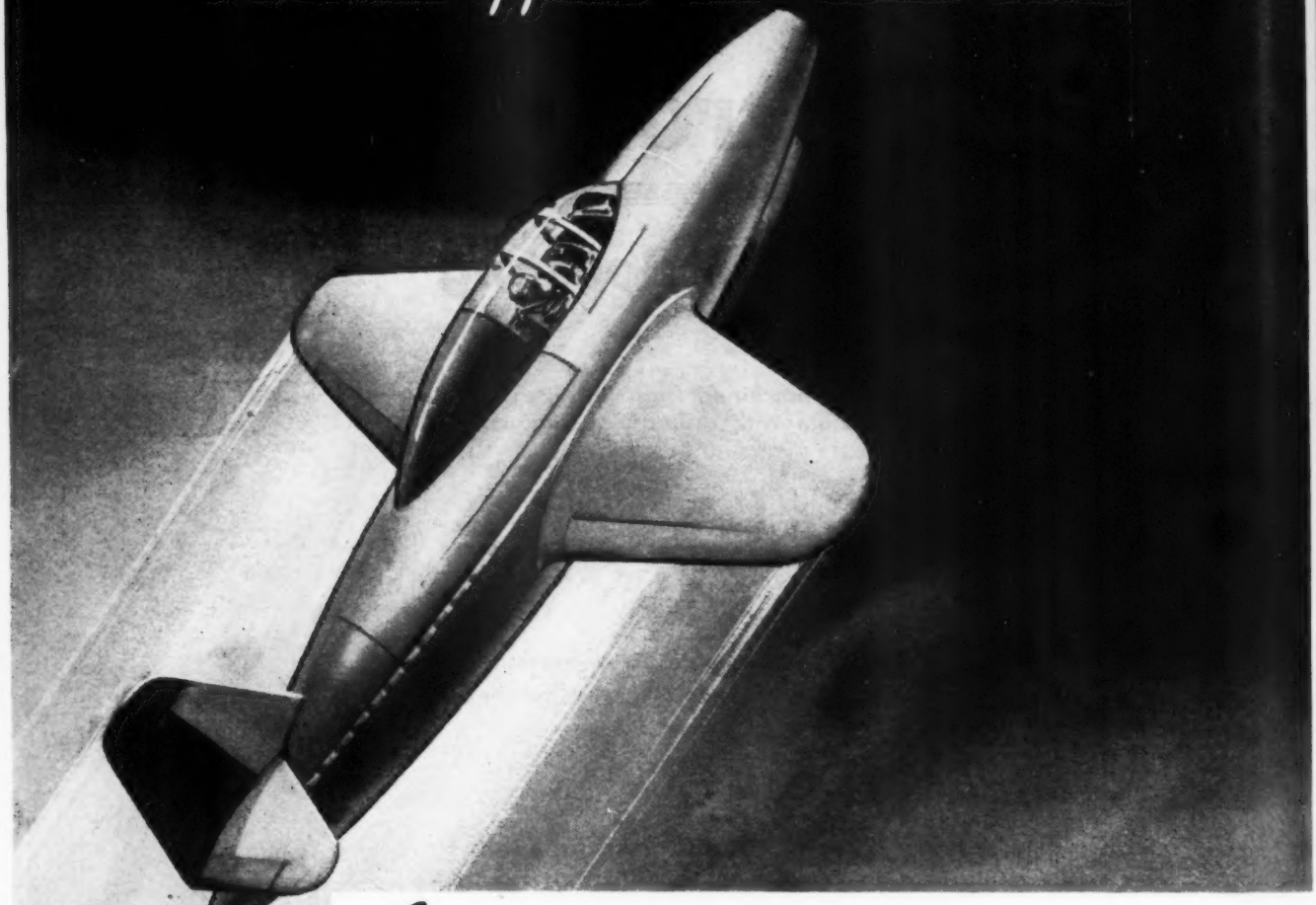
In some cases no machining is necessary on outside or inside surface.

These savings are possible because Rockrite tubing is sized to closer tolerances. It is more concentric, has less ovality. Wall tolerances are half —or less than half—those of conventional cold-sized tubing. Therefore Rockrite tubing can be machined with light cuts of uniform depth, at high speeds.

Many alert manufacturers will use Rockrite tubing to combat rising costs of post-war products—to give users of these products better values.

Inquiries from designers of post-war products will be held in strict confidence.

In the field of JET PROPULSION
SOLAR *applies time-tested skills*



SOLAR is linked with the destiny of jet propelled aircraft. Major jet propulsion engine parts are now being produced in Solar plants under contracts with General Motors Corp. and the General Electric Co.

One of the principal reasons why Solar has been selected to manufacture these particular jet engine parts is because they are made of stainless steel — a metal so difficult to fabricate that it requires exceptional engineering and manufacturing skills.

Solar has acquired these skills during the past fifteen years as the leading manufacturer of stainless steel aircraft exhaust systems . . . has become a recognized authority on design and fabrication of stainless steel parts and structures to resist heat, corrosion and vibration . . . is expert at forming heat resistant metals into intricate shapes and to close tolerances.

Solar's superb stainless steel engineering is being put to good use in the important new field of jet propulsion. It is also available to design engineers in other industries.

SOLAR

STAINLESS STEEL PRODUCTS

SOLAR AIRCRAFT COMPANY SAN DIEGO 12, CALIF. DES MOINES 5, IA.

Ampco offers all the important metalworking processes . . . thus assuring you of the correct process for your purpose

AW-52B

All the inherent advantages of Ampco Metal—its exceptional resistance to wear, impact, fatigue, and corrosion—its specific properties as a series of engineered aluminum bronze alloys, held within close limits by rigid quality control — are available to you in all the forms by which metal is commonly worked. Ampco facilities include

Sand Casting	**Annealing, Heat Treating**
Centrifugal Casting	**Precision Machining**
Forging, Swaging, Rolling	**Welding**
Extrusion	**Other Fabrication (spinning, bending, etc., etc.)**

Ampco also offers you a specialized engineering and production "know-how" to convert your design into a practical manufacturing proposition. Ampco's nation-wide organization of field engineers is ready to assist you. Call on us. Write on your business letterhead for Engineering Data Sheet 125 and Ampco Metal Catalog.

. . . Specialists in engineering — production — finishing of copper-base alloy parts.

AMPCO Metal
The Metal without an Equal

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Dept. PE-4
Milwaukee 4, Wis.
Ampco Field Offices in Principal Cities

Only from Ampco can you get *all* of these services and benefits *conveniently:*

1. Distinctive properties of resistance to wear, impact, fatigue, corrosion.
2. A series of engineered alloys — with physical properties to fit your application.
3. Quality control to hold these properties within narrow limits.
4. Diversified production facilities — coordinating in one place all the commonly used metalworking processes.
5. Engineering and production "know-how" to give you a practical manufacing program.
6. A nation-wide organization of field engineers to assist you.
7. A record of proved performance in hundreds of leading makes of equipment.
8. A national reputation that makes Ampco Metal parts a sales asset.

"Wear-proof" The Products You Sell

ANY SHAPE AVAILABLE

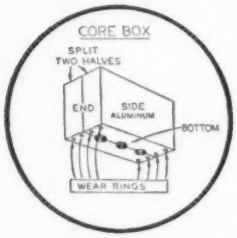
with the HARDEST METAL made by man

Step-up **the life of your product parts as much as 100 times in this simple, inexpensive way:**

When parts are subject to excessive abrasion, "wear-proof" the points of rapid wear with Carboloy Cemented Carbide. Made to any shape and size desired, Carboloy Blanks may be either brazed-in to your part or mechanically fastened—or the entire part can be made of carbide.

Homogenizing equipment, textile machines, bread slicing equipment, business machines, spray guns, etc., are among the many types of equipment now performing with increased efficiency after being "wear-proofed" with Carboloy Cemented Carbide.

Is excessive wear a problem in your products? Write for booklet WR-101R.



CARBOLOY Wearproofed Parts Resist Even Sand!

Aluminum foundry core boxes were fast scraping over sand. 8 Carboloy rings brazed to bottom increased life 10 times.

TO STOP EXCESSIVE WEAR on vital parts of your product

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CEMENTED CARBIDE for WEAR-RESISTANT USES

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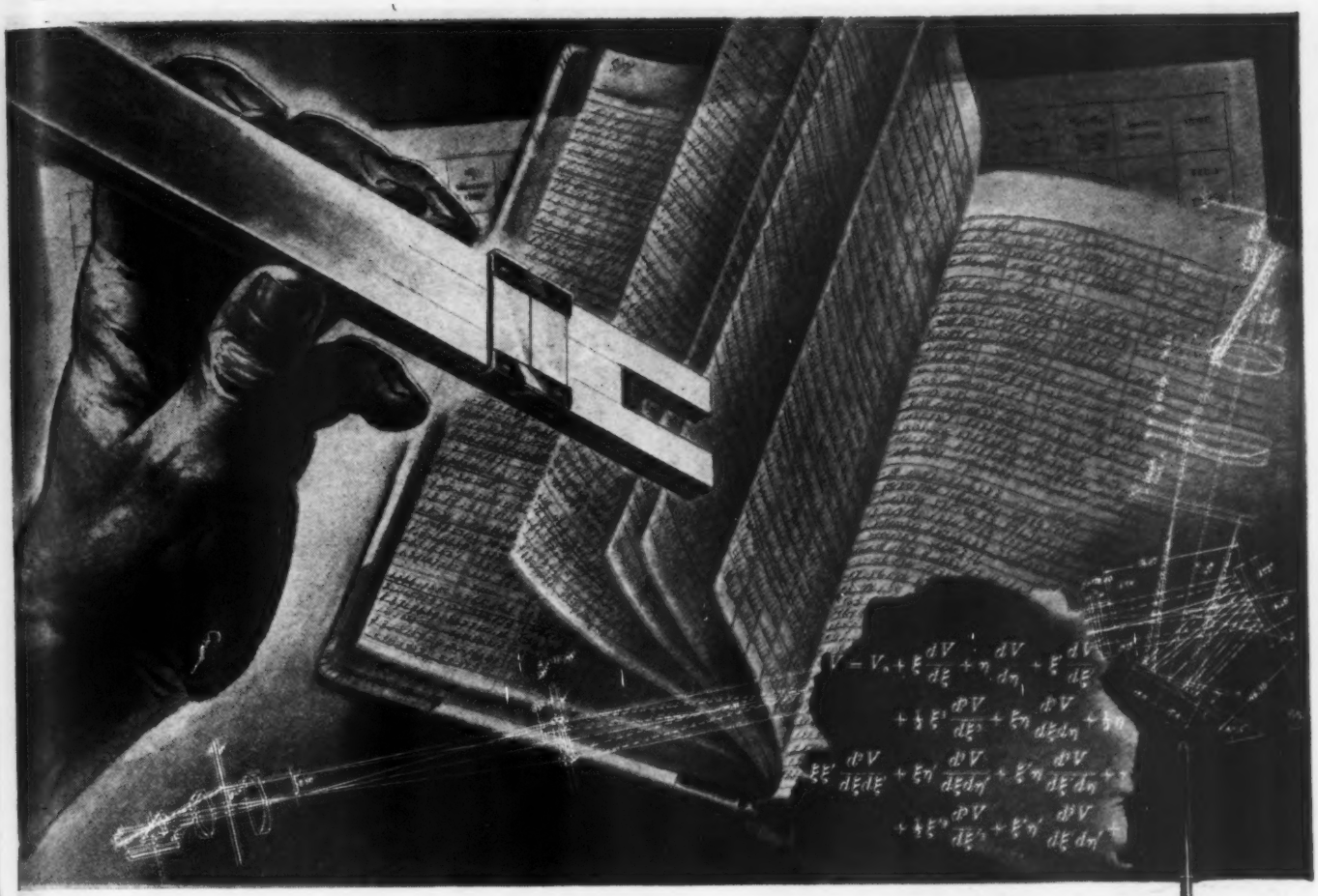


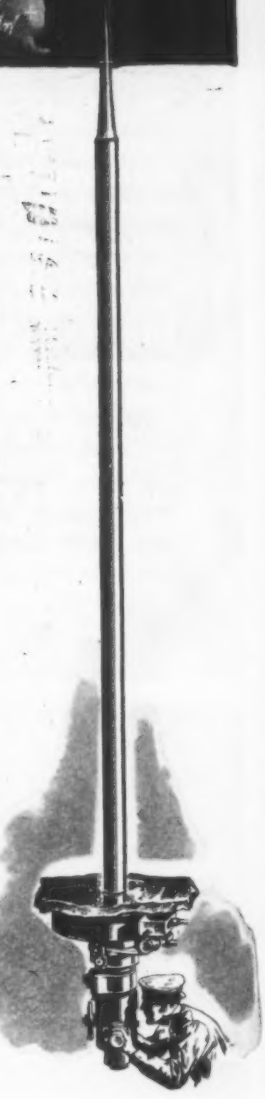
Solving the Unsolvable . . .

Like the voyager into Infinity, the optical designer can approach, but never attain, his goal. In the enigmatic equations of light, an ultimate resolution of all complex variables is inherently impossible.

Seeking a more nearly ideal image, the creative mathematician often labors years evolving a new formula—struggles with cabala of computation, cryptic coefficients, sines, roots, logs, exponents, derivatives, indices of refraction and dispersion. The designer and his computers, with calculating machines, make hundreds of tedious trials and fill endless pages with symbols and figures. Few scientists face more trying problems, for in the perverse mathematics of optics, as one distortion is reduced, another increases. Three months to three years of simplifying and refining the equations of mathematical physics are rewarded by the evolution of a superior lens system with optimal freedom from all the aberrations.

Kollmorgen mastery of design is matched by craft production in metals and glass, unsurpassed in accuracy. The largest makers of sub periscopes, Kollmorgen produces with extreme precision mechanisms ranging in weight from a few grams to a ton, and elements varying from pin-head size to huge anastigmatic objectives. Experience embraces the entire field of optical devices and instruments

At present, our entire production is concerned with periscopes, navigational and fire control instruments, and other devices still secret. When Navy needs are met, Kollmorgen technicians and facilities will be available for peacetime products. Perhaps you have in mind some project, either mechanical or optical, to which our experience, skills, and ability can contribute. We welcome consultation in confidence.



KOLLMORGEN OPTICAL CORPORATION

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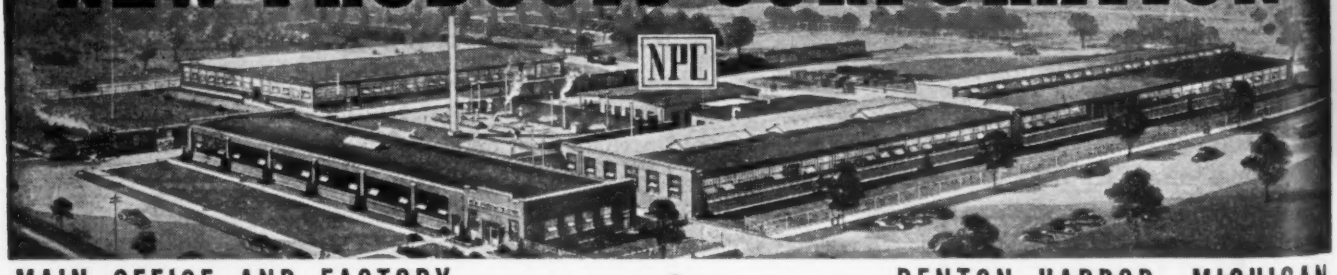
A FULL MEASURE OF DIE CASTING "Know How"

This high pressure aluminum die casting has variations in wall thickness from .093" to over ½" in immediately adjacent sections — another complicated job expertly handled by New Products Corporation's experience and facilities. . . . This combination of modern techniques, and scientific control of materials and production means a full measure of Die Casting "know - how" for every customer. Your products deserve this same critical attention. Let our staff of engineers help solve your problems. . . . Plan now.

HIGH PRESSURE DIE CASTINGS

★ ALUMINUM
★ MAGNESIUM
★ ZINC

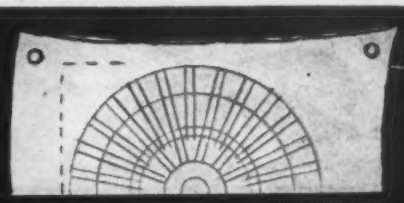
NEW PRODUCTS CORPORATION



MAIN OFFICE AND FACTORY • BENTON HARBOR, MICHIGAN

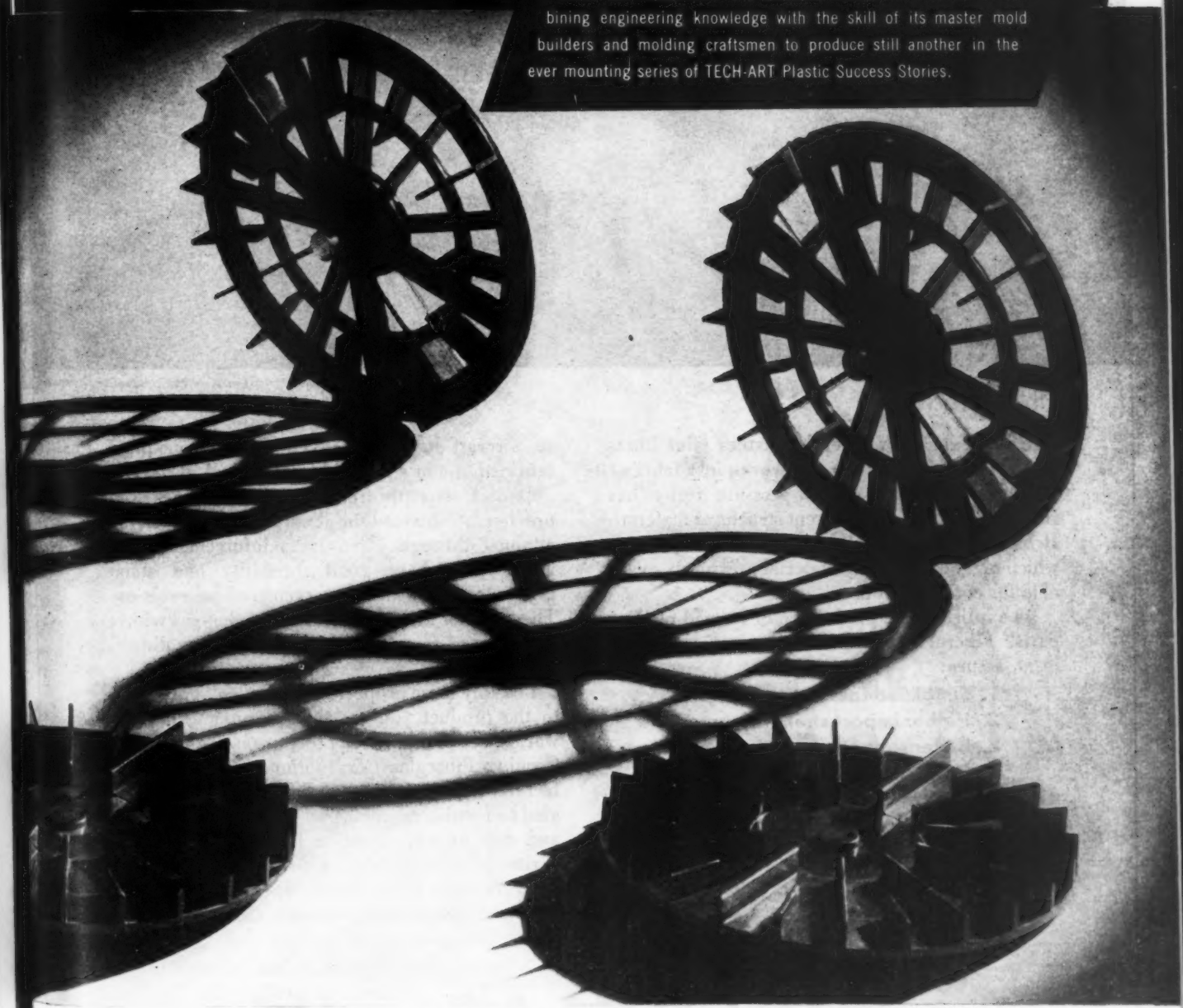
REVOLUTION-ARY *Ideas . . . Molded in* PLASTICS

Revolutionary in their functional use as well as in their concept have been many of the products molded by TECH-ART. Never in today's practice need plastics be considered a media for products of static use only. Instead, more and more products having dynamic functions are being engineered and produced under the trained minds and skilled hands of TECH-ART's engineers and craftsmen. TECH-ART's vast facilities include every type of compression and compression-transfer molding equipment, as well as a large battery of injection molding units. Add to this TECH-ART's broad experience in product engineering and development and you have the best assurance that your product, too, in the hands of TECH-ART, will become another Plastic Success Story.



Another Plastic Success Story

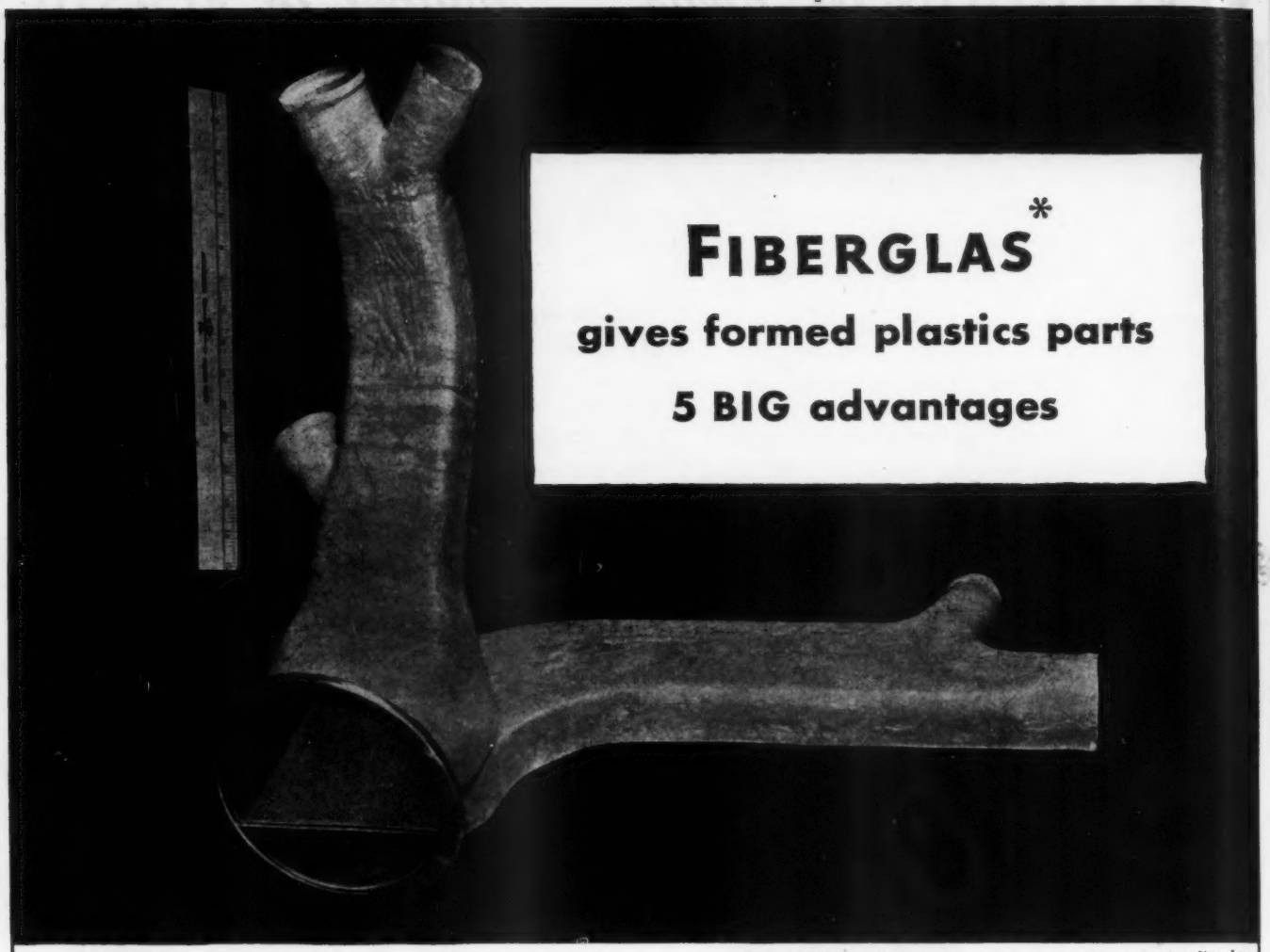
The Permutit Company brought these impulse and impeller wheels to TECH-ART to mold. To revolve at speeds as high as 3200 r.p.m., their thin fins had to be extremely strong. Precision molding and the use of materials that would not warp was essential if the delicate balance of rotary action was to be maintained. The fact that TECH-ART has delivered many thousands of these finely balanced parts to this leading manufacturer of chemical measuring instruments and equipment is a splendid example of the art of combining engineering knowledge with the skill of its master mold builders and molding craftsmen to produce still another in the ever mounting series of TECH-ART Plastic Success Stories.



TECH-ART
PLASTICS COMPANY

4 times winner of the coveted Army and Navy "E" Award

36th Ave. and 41st Street • LONG ISLAND CITY, N. Y. • Tel. AStoria 8-6050-1
SUCCESSORS TO BOONTON RUBBER MANUFACTURING COMPANY



Complicated aircraft duct saves man-hours on the production line because ducts are not dented or permanently deformed during installation.

The combination of Fiberglas textiles (fine fibers of glass twisted into yarn and woven into fabrics) and certain contact or low-pressure resins has resulted in a new and different structural material. It has many significant properties and qualities which excel those of any material previously available for commercial use.

As applied to the production of formed plastics parts, Fiberglas textiles, used as a reinforcement, assure:

1. **Simplified fabrication**
2. **Higher impact strength**
3. **Better strength-to-weight ratio**
4. **Greater rigidity**
5. **Dimensional stability**

In the production of dies and jigs, structural forms and complicated parts, the necessity of metal dies and machining is avoided, important time and cost savings are effected. For example, the aircraft duct, illustrated above, is a one-piece fabrication, not an assembly of several parts.

Impact strength from five to ten times that previously obtained in laminates is now being attained through Fiberglas reinforcement. The glass fibers have great flexibility and stand high stresses without permanent deformation. They are not affected by moisture changes within the range of commercial usage, remaining dimensionally stable.

Possibly these properties suggest an application to the product you are now manufacturing for war, or are planning for postwar markets. Owens-Corning Fiberglas Corporation does not manufacture resins or finished laminates but will be glad to furnish experimental samples of Fiberglas and data on techniques in its use with plastics. Write: *Owens-Corning Fiberglas Corporation, 1878 Nicholas Bldg., Toledo 1, Ohio. In Canada, Fiberglas Canada Ltd., Oshawa, Ontario.*

FIBERGLAS . . . A BASIC MATERIAL

*T. M. Reg. U. S. Pat. Off.

Could you write this letter to your Finish Supplier?

THE F. W. Wakefield BRASS COMPANY
SPOT FLUORESCENT AND INCANDESCENT LIGHTING EQUIPMENT
VERMILION, OHIO — TELEPHONE: 2100

Ault & Wiborg Corporation
P. O. Box 17, Evanston Station
Cincinnati 7, Ohio

June 15, 1944

Gentlemen:

We have received your letter of June 13th regarding the salt spray test you conducted on panels we forwarded to you sometime ago. We also have the panels themselves.

We would like to express our appreciation of your efforts in this instance. This test has been very helpful.

At this time I would like to repeat what I have often said before. We appreciate the service and quality of material which your company furnishes. We also appreciate the kind of cooperation you give us on delivery and in the handling of information relative to delivery of orders. The technical help you give us from time to time is also very helpful. Our relations with you have been very pleasant and we hope that this condition will continue as long as we require the type of finishes you furnish.

It is very pleasant signing orders which are going to suppliers who perform as you have. Wishing success for you personally and for your company during the coming years, I am,

Very truly yours,
THE F. W. WAKEFIELD BRASS COMPANY
Carl A. Schroeder
Secretary

Cold-rolled steel diffusing shields for F. W. Wakefield Brass Company's fluorescent lighting fixtures are sprayed with one coat of high-reflectance white Polymerin* and baked for ten minutes at 300° F. in a near infra-red radiant energy oven. High-reflectance white Polymerin provides a minimum reflectance of 85 percent, in contrast with ordinary enamels' reflectance value of approximately 79 percent. Thus, for F. W. Wakefield Brass Company, Polymerin both speeds production and helps them produce products of highest quality.

A&W POLYMERIN

The Original Speed-bake finish

A PRODUCT OF AULT & WIBORG DIVISION OF INTERCHEMICAL CORPORATION

*Reg. U.S. Pat. Off.

PE-4

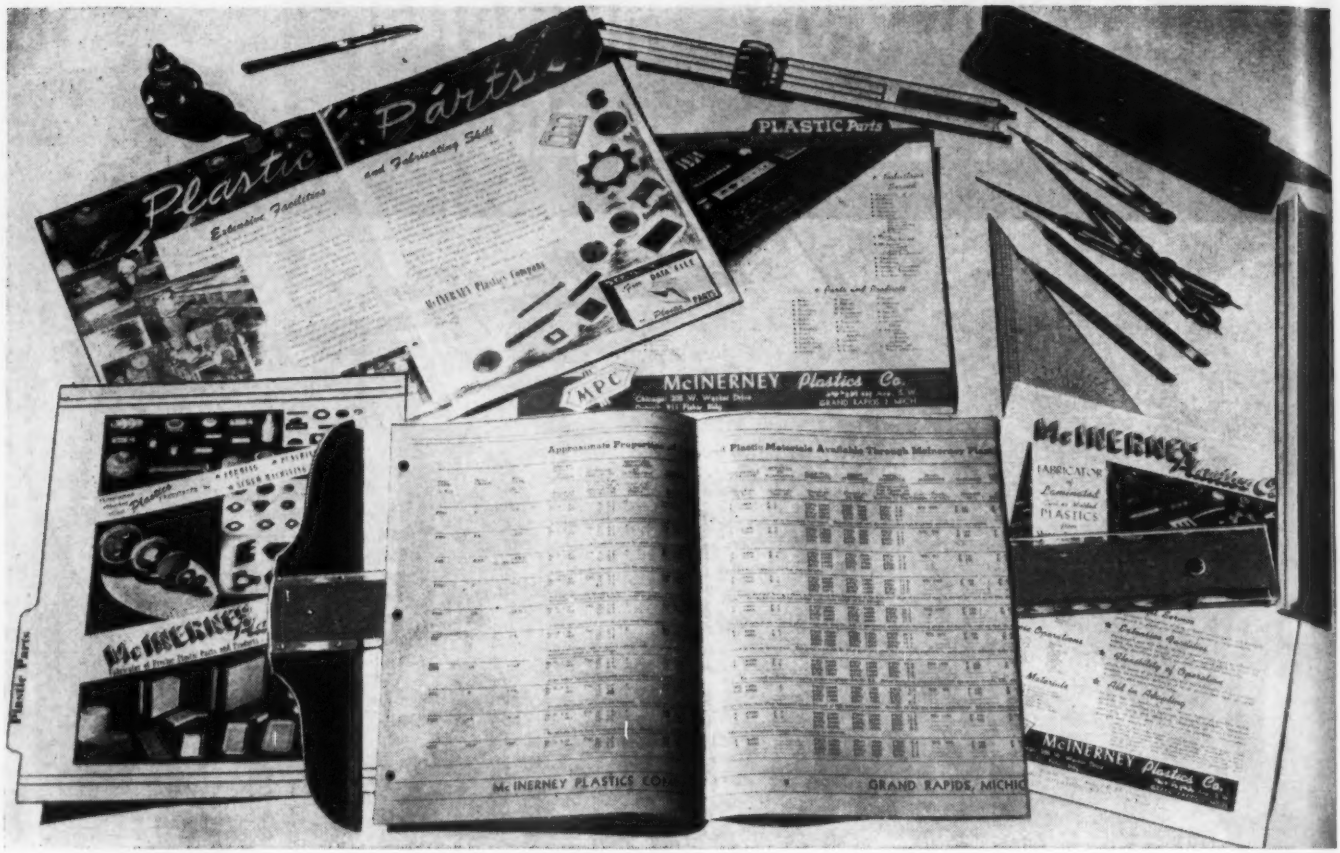
Ault & Wiborg Division of Interchemical Corporation
350 Fifth Avenue, New York 1, N. Y.

Please send, without obligation, "The Facts on Polymerin"—the 32-page, illustrated booklet which tells in detail how Polymerin has increased production speeds and provided a more durable finish for leading products of nine major industries.

Name.....

Company.....

Address.....



Have You Considered Using FABRICATED PLASTIC PARTS

--for These Products

Bases
Bearings
Bobbins
Boxes
Bushings
Cams
Clamps
Containers
Fair-Leads
Gaskets
Gears
Guides
Instrument Panels
Insulators
Liners
Plugs
Pulleys
Punchings
Rubbing Strips
Rollers
Structural Angles
Terminal —Blocks —Boards —Strips
Washers
Many Others

--from These Materials

★ Laminated Phenolics
—paper
—fabric
—asbestos
—wood
—fibre glass
★ Neoprene
★ Cellulose Acetates
★ Methyl Methacrylate
★ Polystyrene
★ Fish Paper
★ Cork, and
★ Vulcanized Fibres
★ Sheets—Rods—Tubes

--Using These Operations

Assembly
Blanking
Broaching
Buffing
Counter-Boring
Sinking
Drilling
Engraving
Filing
Forming
Hobbing
Jointing
Machining
Marking
Milling
Planing
Piercing
Punching
Post Forming
Reaming
Riveting
Shaving
Silk-Screening
Spraying
Tapping
Threading
Tumbling
Turning
Varnishing and Many Others

• Our business is the production of FABRICATED plastic parts and products, exclusively.

• We utilize LAMINATED, molded and cast plastic materials in sheet, rod and tube stock form. Plastic materials of many varied physical properties are available through us to fabricate for almost any industrial, mechanical, electrical or chemical application.

• As a buyer, designer or product engineer, you will find helpful our literature on "Plastic Parts" and the physical properties of plastic materials available. Send for this convenient file folder.

Ask for Bulletin 27 . . . FREE
when requested on your company letterhead.

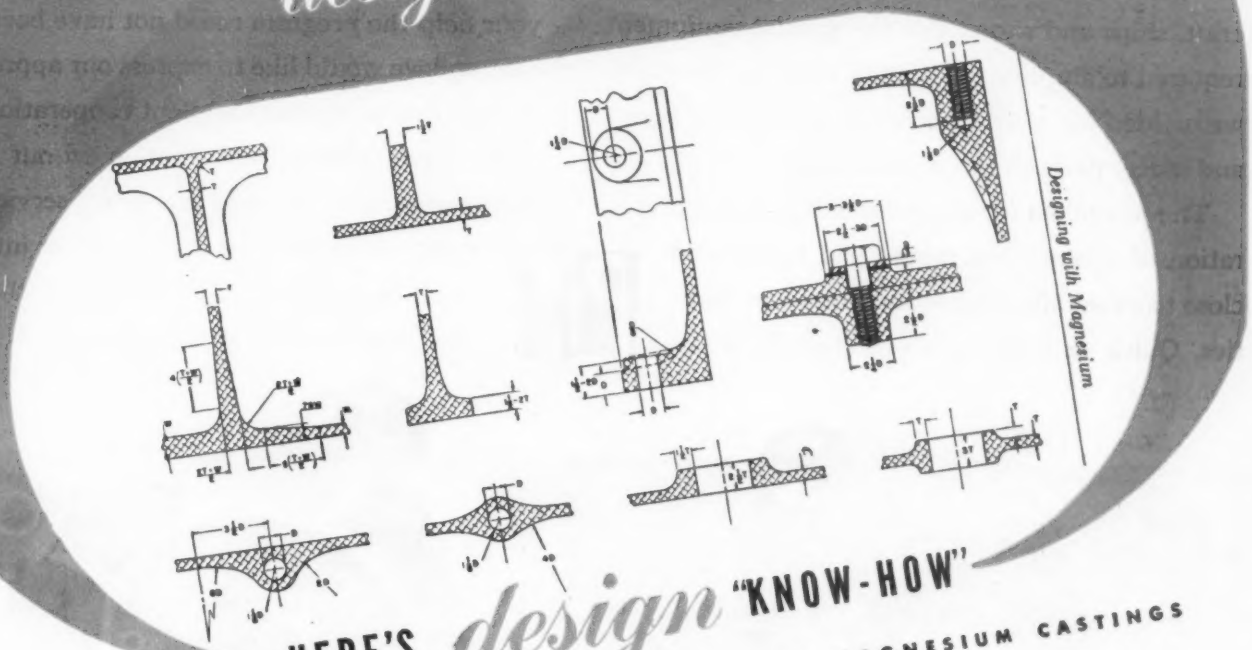
MPC

McINERNEY *Plastics Co.*

Chicago: 205 W. Wacker Drive
Detroit: 911 Fisher Bldg.

27 Commerce Ave., S. W.
GRAND RAPIDS 2, MICH.

AMERICAN MAGNESIUM CORPORATION OFFERS YOU "KNOW-HOW" IN *design...manufacturing*



HERE'S *design* "KNOW-HOW"

EXAMPLES OF SECTION JUNCTIONS AND EMBOSSING IN MAGNESIUM CASTINGS

Help yourself to more than twenty years of experience in working with magnesium. American Magnesium will gladly share the "know-how" gained through many years of designing, manufacturing, and assembling magnesium parts.

This experience translates itself into better products for you—more efficient designs, maximum savings in weight. Then, as you place your designs in production, look to American Magnesium for dependable castings, forgings, extruded shapes, and sheet.

May we assist you in employing the weight-saving properties of magnesium to best advantage? Write to Aluminum Company of America, Sales Agent for Mazlo Magnesium Products, 1702 Gulf Building, Pittsburgh 19, Pennsylvania.

MAGNESIUM MAZLO PRODUCTS

AMERICAN MAGNESIUM CORPORATION

SUBSIDIARY OF ALUMINUM COMPANY OF AMERICA

Plastic Throat Parts for a BIG VOICE!

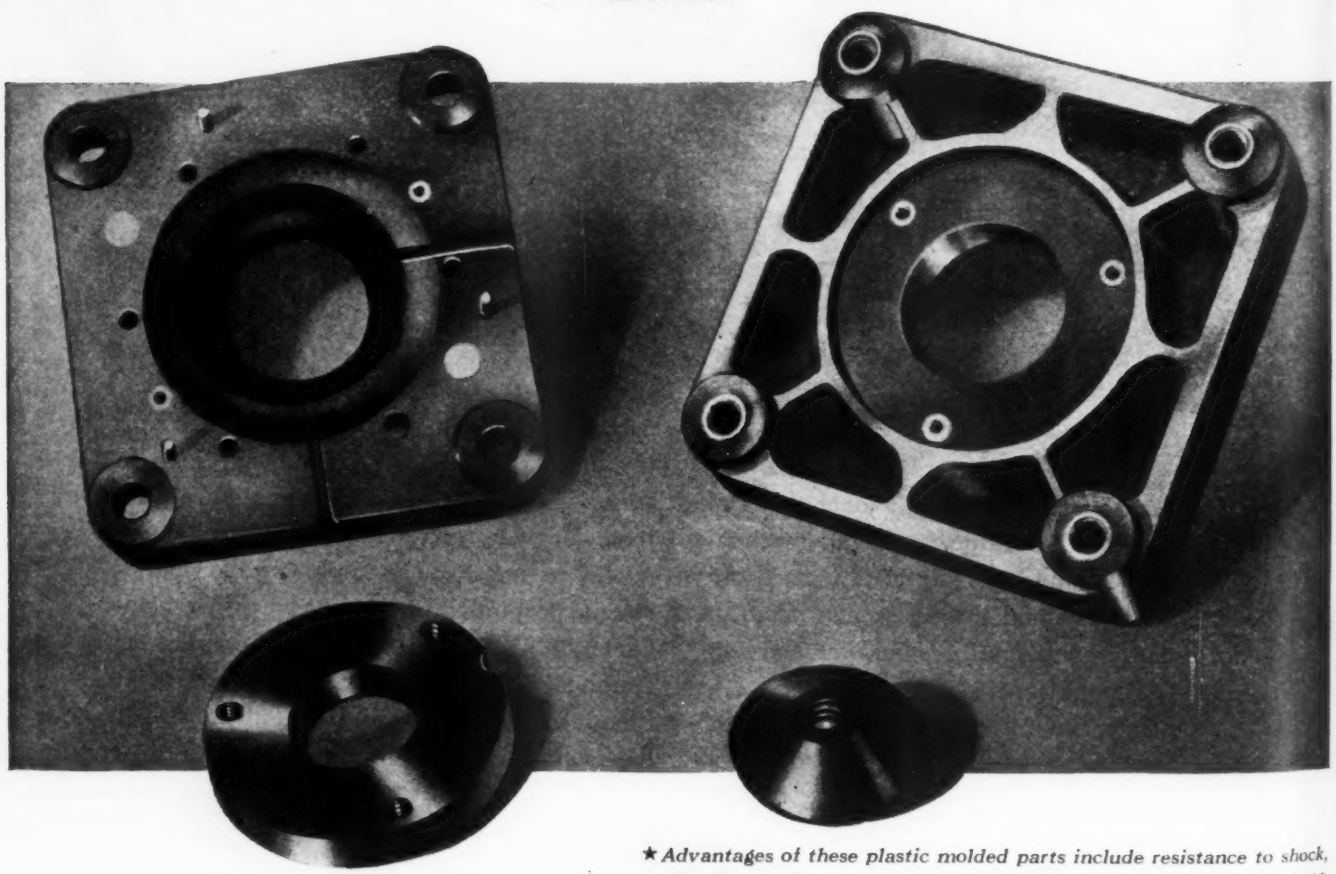
A voice strong enough to carry across miles of sea and land . . . and to be heard above the sounds of battle . . . urgent, time-saving words of command and direction. This was the voice needed by the Navy to co-ordinate operations between landing craft, ships and shore. For the special equipment required to amplify the human voice for this need we molded the plastic horn throat, receiver, insert and spacer parts shown on this page.

The job called for precise molding and incorporation of inserts. Tolerances had to be held close to avoid affecting sound and tone qualities. Quick delivery was essential. How we met these requirements is indicated by this quotation from a letter sent to us by Western Electric Company, makers of the amplifying system:

"Your company was called upon to furnish all of the required plastic parts. We feel that without your help the program could not have been a success, and we would like to express our appreciation of your fine work and excellent cooperation."

We have collected information on our plastics engineering, molding and assembly services in a most convenient form. If you are interested in obtaining product improvement thru plastics, write for free Folder File PE 4.

PM
REG. U.S. PAT. OFF.



★ *Advantages of these plastic molded parts include resistance to shock, vibration and corrosion. Exceptionally close tolerances are held.*

PLASTIC MANUFACTURERS

INCORPORATED

STAMFORD, CONNECTICUT

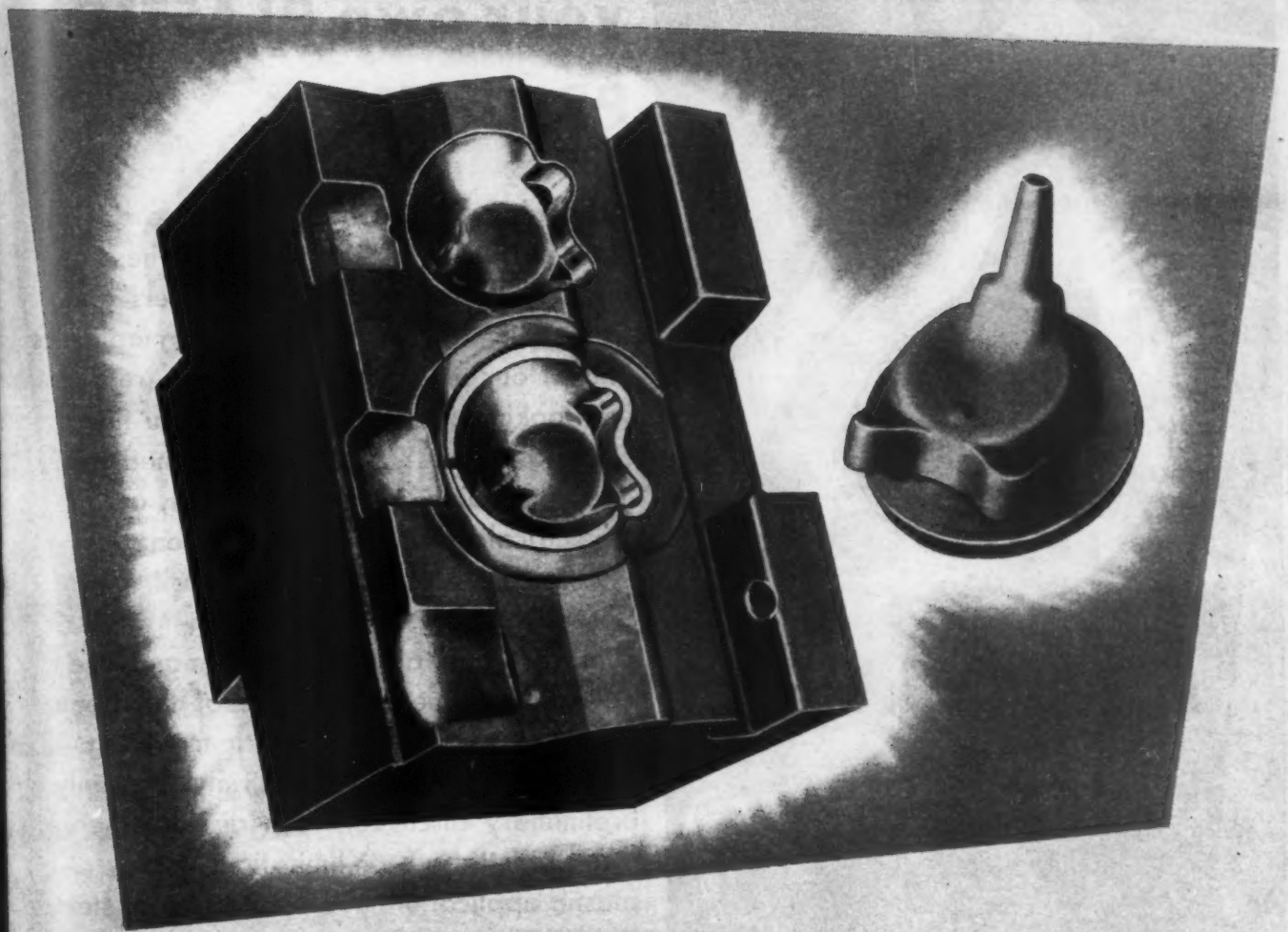
MOLD MAKING • INJECTION & TRANSFER MOLDING • COMPLETE ASSEMBLY

Representatives: DETROIT 2—805-06 New Center Bldg. • LOS ANGELES 35—1440 So. Robertson Blvd.

CANADA—A. & M. Accessories Ltd., 19 Melinda Street, Toronto; 1405 Bishop Street, Montreal; 920 Second Avenue, Seattle

T & W FORGINGS

Usually Cost Less at the Point of Assembly



Designs that permit forging close to the contour of the part at the point of assembly reduce machining and finishing costs.

Ask a T & W Forging Engineer for comparisons of designs and costs on forgings at the point of assembly

TRANSUE & WILLIAMS

STEEL FORGING CORPORATION • ALLIANCE, O.

SALES OFFICES: NEW YORK, PHILADELPHIA, CHICAGO, INDIANAPOLIS, DETROIT AND CLEVELAND

Moulded for U. S. Electric Manufacturing Corp.

Throwing a light on your own PLASTIC PROBLEM

Flashlights may have everything to do with your particular plastic problem. These three models with all their brothers and sisters run the full gamut of thermoplastics and of our moulding techniques. Are you looking for toughness? Do you need close tolerances? Are you concerned over deep threading, or a certain color, or dielectrical properties, or corrosion resistance, or proof against shock, or closeness of fit — or even water-tightness? These are only a few of the demands we have had to meet. Everyone of them can be translated into your plastic moulding job. But the Trio believes firmly that only preliminary discussions can disclose the true potential use or limitations of any plastic application. We would like to start right there — with you.

For Custom Injection Moulding . . . try the Trio

ARMY E NAVY

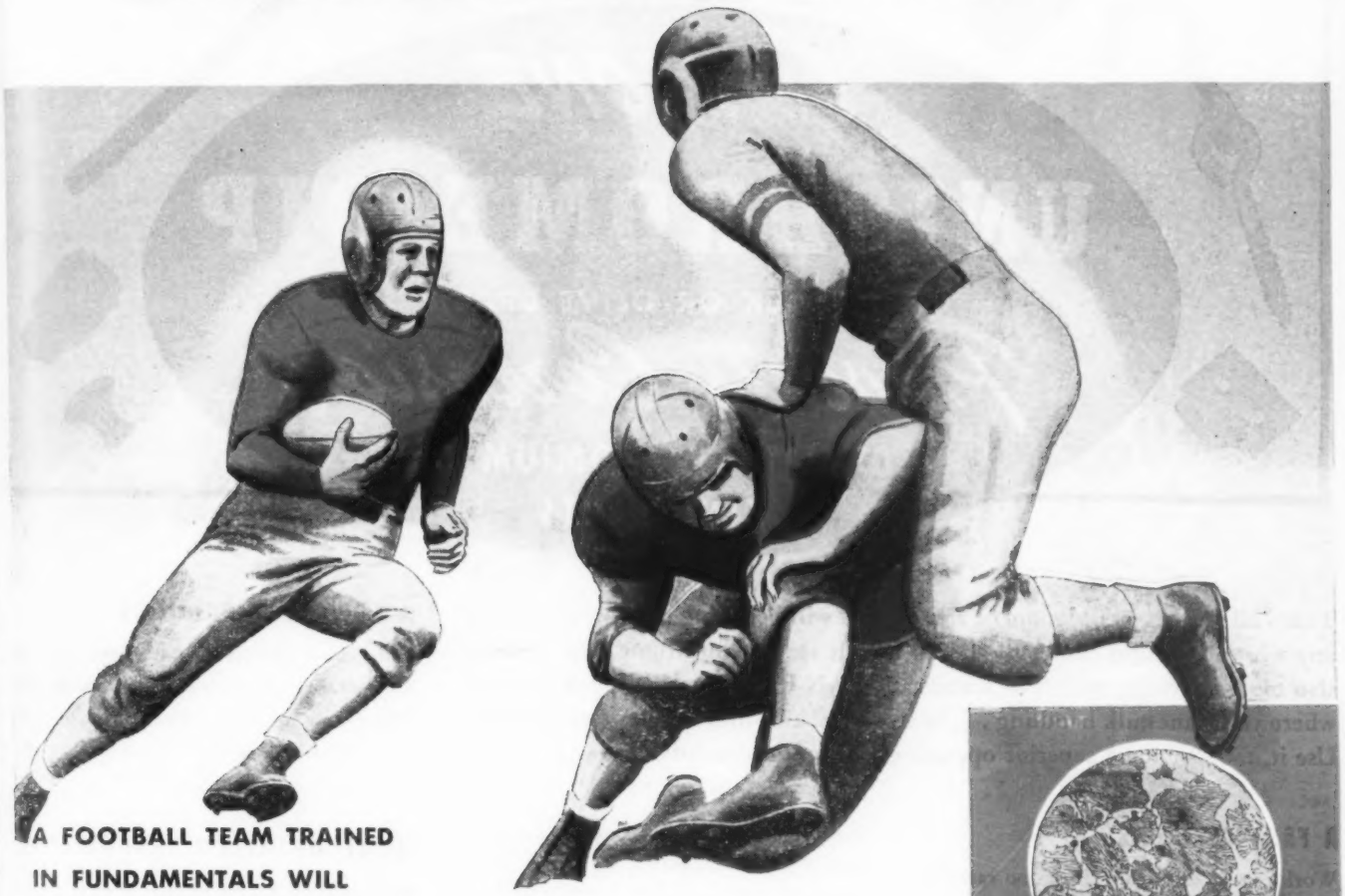
Custom Injection Moulders

WORCESTER MOULDED PLASTICS COMPANY

8 GRAFTON STREET WORCESTER 8, MASSACHUSETTS

17 EAST 42nd ST., NEW YORK 17, N. Y.

MAINTENANCE OF STRUCTURE IS FUNDAMENTAL IN MACHINABILITY.....



A FOOTBALL TEAM TRAINED IN FUNDAMENTALS WILL EVENTUALLY WIN OVER TEAMS RELYING ON RAZZLE DAZZLE PLAYS

How often have you witnessed a football game on an autumn Saturday afternoon between a team relying almost entirely on trick plays, but noticeably weak in blocking and tackling,—the other team definitely schooled and trained in *fundamentals*, relying on good blocking, deadly tackling. The razzle dazzle team gives the spectators some thrills—but the team trained in football fundamentals usually comes through with the winning score.

Wyckoff metallurgists recognize that the continual reproduction of a desired structure is *fundamental* to the maintenance of consistently satisfactory machining production.

Wyckoff will welcome the opportunity of explaining the *fundamentals* of Structure Controlled Annealing.

Write for information.

WYCKOFF STEEL COMPANY

General Offices: **PITTSBURGH 30, PENNA.**

Works: **AMBRIDGE, PENNA.; CHICAGO, ILL.; NEWARK, N. J.; PUTNAM, CONN.**

Manufacturers of Carbon and Alloy Steels . . . Turned and Polished Shafting . . . Turned and Ground Shafting . . . Wide Flats up to 12" x 2" . . . Complete Annealing and Heat Treating Facilities.

That's all it takes on cadmium or zinc. And it will be a long time before you see any white corrosion products — even in salt spray. Unichrome Dip coatings also meet the requirements of specification AN-P32a. Use this speedy process where you want bulk handling . . . low cost . . . a lustrous black or olive finish. Use it, too, for these superior operating and production advantages.

A FAST PROCESS

Work can be handled in bulk—no racking or current needed. After the single dip, parts can be rinsed in hot water without impairing adherence of the surface, and dried quickly by centrifuge or air blast.

SIMPLY CONTROLLED SOLUTION

It requires no chemical analysis for maintenance, and only slight additions of the proper Unichrome Dip compound for replenishment. The solution has excellent tolerance for such common contaminants as metals, cyanides, phosphates and sulfates.

USUAL BULK EQUIPMENT

Use any type of acid-proof tanks or crocks with this process. Electrical equipment is not needed nor is filtering or continuous agitation necessary. And operation is at *room temperature.*

A LOW-COST PROCESS

Unichrome Dip compounds are used in moderate quantities and are reasonably priced. The solution is free-rinsing and can be replenished several times before discarding.

MORE DETAILED INFORMATION

will be supplied on request. Write to the nearest office and tell us the kind of parts you are considering, the quantity and size. Immediate attention will be given your inquiry.

OTHER U.C. PRODUCTS AND PROCESSES TO SERVE YOU

CHROMIUM PLATING for wear-resisting, oil-retaining and other types of finishes.

☆**UNICHROME ALKALINE COPPER** for smooth, lustrous copper plating in a non-cyanide bath.

☆**UNICHROME STRIP** for speedy removal of copper, chromium, zinc, etc., from steel and cast iron without etching the base.

☆Trade Mark Reg. U. S. Pat. Off.

☆**ANOZINC** salts for anodic treatment of zinc giving greatly increased corrosion-resistance.

☆**UNICHROME RACK COATINGS**

☆**UNICHROME STOP-OFF LACQUERS AND COMPOUNDS**

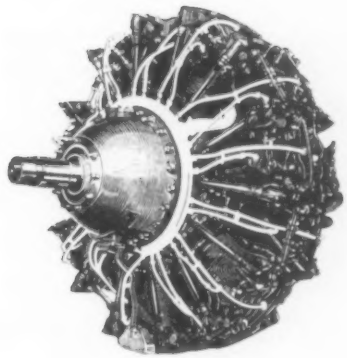
☆**UNICHROME CLEAR LACQUERS**

☆**UCILON** — a corrosion-resistant coating for protecting surfaces against acids, alkalies, water, gasoline and various corrosive chemicals.

UNITED CHROMIUM
INCORPORATED
51 East 42nd Street
New York 17, N. Y.
Waterbury 90, Conn. · Detroit 7, Mich.

The key to Roxalin's success in helping industry produce better looking, longer lasting products is the engineering skill with which it transfers the unique strength, beauty and chemical resistance inherent in the basic plastics to conveniently applied surface coatings.

a new finish for a flying horse collar!



RECENTLY, subcontractors of the largest manufacturers of airplane engines had a tough nut to crack. Cadmium, normally used to plate their ignition harness manifolds, was a critical material. A substitute had to be found.

They had to find a metal finish that would adhere stubbornly to *steel, brass and silver solder* through all ranges of temperatures—all degrees of humidity—and withstand the abuse of installation without chipping from the metal.

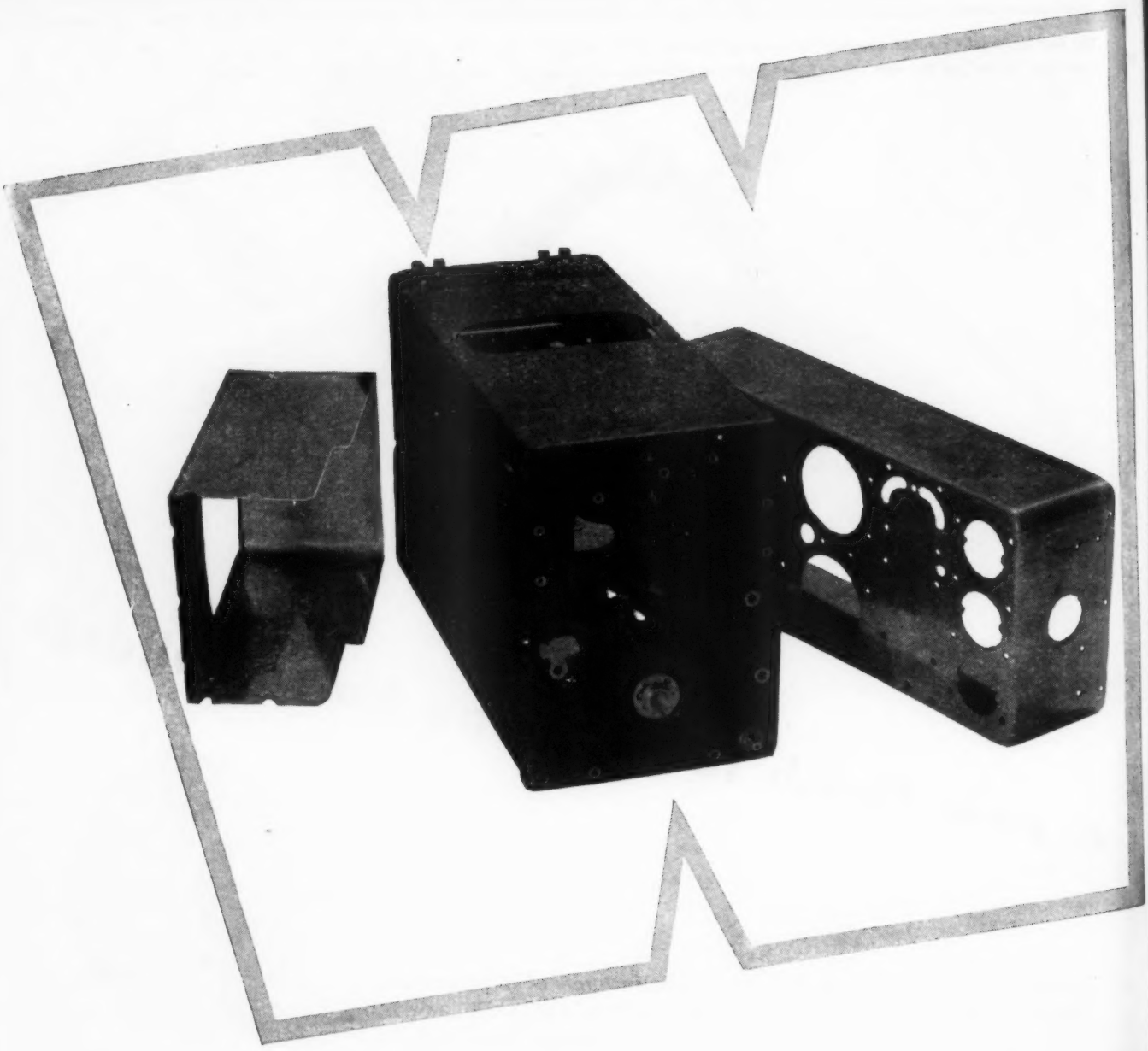
Result? The answer was found to be Roxalin's plastic base Paladin—a coating specially engineered for use on hard to finish metals where conventional lacquers and enamels won't adhere.

Accelerated weathering and salt spray tests prove the complete schedule, consisting of Paladin Primer followed by a coat of synthetic enamel, surpassed all government requirements established for this job.

What is *your* tough job? Our files of special purpose finishes for all branches of industry —and the skill and experience of our technical staff—are at your disposal. Write to Department 806 for complete information.

ROXALIN *flexible* FINISHES
INCORPORATED
ELIZABETH, N. J. • NEW JERSEY

PIONEERS IN PRODUCT FINISHES ENGINEERED FOR SPECIFIC PERFORMANCE



Close Tolerances in Light Gauge Aluminum Stampings

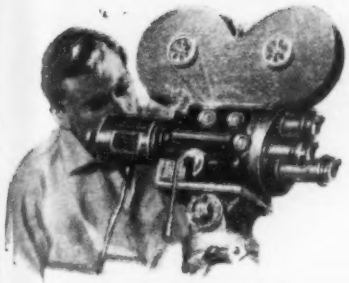
Stamping 100,000 intricate parts a month for Airborne Command radio sets is definitely a job for a plant with unusual facilities and thorough experience. All holes in these parts must be held to very close tolerances to prevent rattle under severe vibration. The small section shown is stamped from .020″ aluminum 52S. All corners are accurately and smoothly rounded without cracking.

Why not investigate Presteel possibilities for lowering costs and improving production on your own products by the use of metal stampings? Mail samples or prints to

WORCESTER PRESSED STEEL CO.

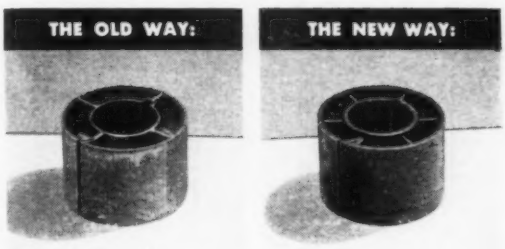
704 Barber Avenue, Worcester 6, Mass.

ALLOY STEELS AND OTHER METALS COLD FASHIONED SINCE 1883



FILM CORES OF "PLASTACELE"

Cost less... weigh less... maintain dimensional stability

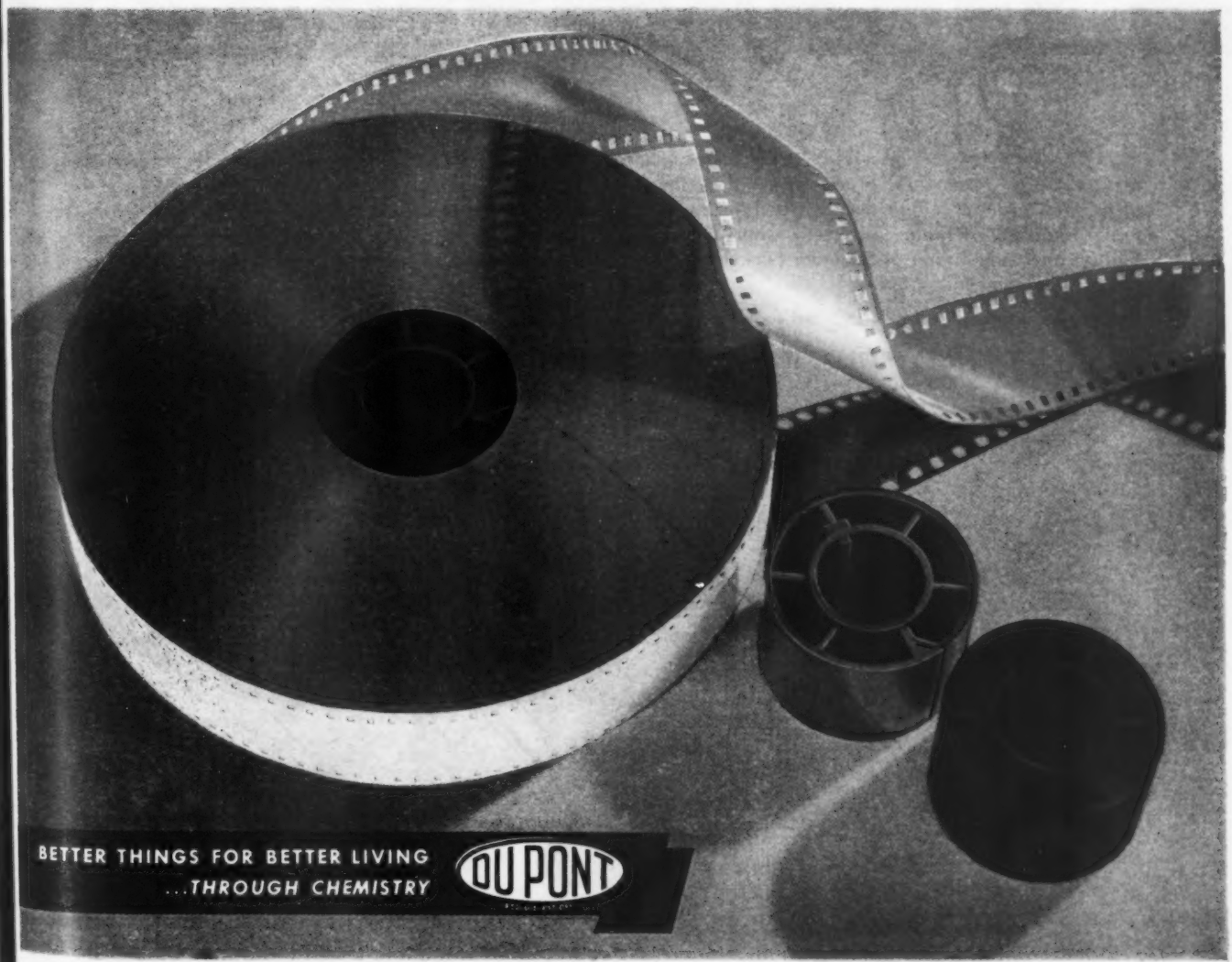


The old way: Metal core weighed 81.5 grams.
The new way: Core of Du Pont "Plastacele" weighs 27.0 grams. Molded for the Du Pont Photo Products Department, Wilmington 98, Del., by A. L. Hyde, Grenloch, New Jersey.

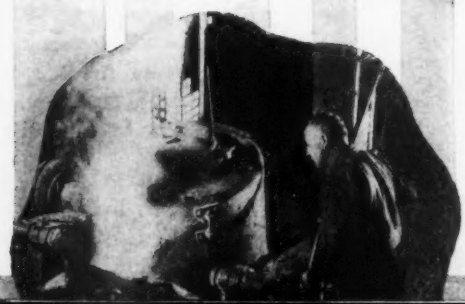
FOR PLASTICS CONSULT DU PONT

ADVANTAGES: These film cores of "Plastacele" cellulose acetate plastic have shown that they possess exceptional dimensional stability. In addition, they cost less, are lighter in weight, and will not corrode. Today these cores, which are designed to hold up to 2,000 feet of motion-picture film in 16 mm., 32 mm., and 35 mm. sizes, are made in green (to identify negative film) and brown (to identify positive film). Six cores are injection-molded at one "shot" for each 30-second cycle. Unlike some other plastics considered, "Plastacele" does not attack or fog the film. Because they do not bend out of shape, the plastic cores do not throw the film out of line if they happen to become damaged in use or in transit.

AVAILABILITY: Du Pont "Plastacele" is under WPB allocation. For information or experimental quantities write: E. I. du Pont de Nemours & Co. (Inc.), Plastics Department, Arlington, New Jersey.



SEYMOUR



NICKEL SILVER

When the war is over, Seymour Nickel Silver will resume its role in the manufacture of untold thousands of useful and ornamental products. Chief of these is plated ware, for which it is the ideal base. Because of its even grain and fine ductility, it flows smoothly under spinning tool or forming die. And, when eventually exposed by wear, its silvery white color will match the surrounding plate and take a high polish. Still another advantage of Seymour Nickel Silver is that no preplating is necessary on articles to be silver, nickel or chromium plated.

If you are interested, we'll be glad to help you plan your postwar products.

THE SEYMOUR MANUFACTURING CO., SEYMOUR, CONN.

Using Strength, Lightness, Wearing Quality

STRENGTH, light weight and wear-resistance make Synthane laminated highly desirable for retainers in high speed ball bearings . . . and an excellent example of putting plastics where plastics belong.

If you haven't used plastics at all or to the fullest extent, if you are not certain *which* of the many plastics fits into your plans . . . or where . . . or why . . . or what the cost will be . . . ask us to help you, preferably *before* you design.

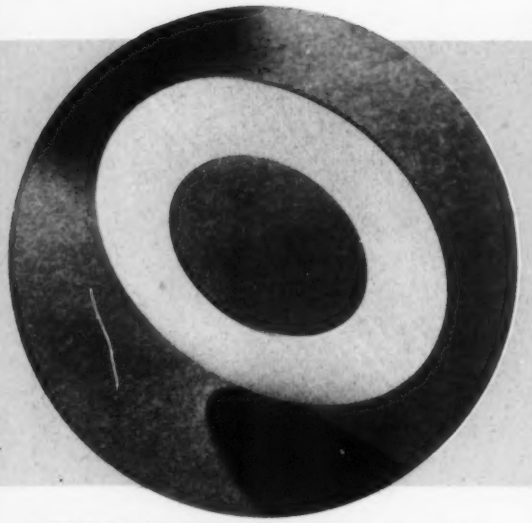
This way, if Synthane is the answer to your needs, you can be sure of design and material not only right for the application but right for fabrication. Should you, in addition, want us to take over fabrication, you can be sure your parts will be produced by men who know machining of plastics, working on machines fitted especially for plastics. For your whole job or any part of it—design, materials or fabrication—remember Synthane. It will give you a real sense of satisfaction to know whether the job can be done, how it can be done, how long it will take to produce and how much it will cost. Synthane Corporation, Oaks, Pa.

SYNTHANE TECHNICAL PLASTICS ARMY E NAVY **DESIGN · MATERIALS · FABRICATION**

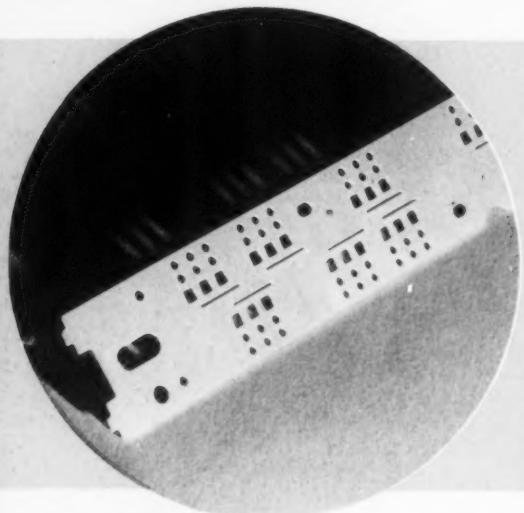
SHEETS · RODS · TUBES · FABRICATED PARTS · MOLDED-MACERATED · MOLDED-LAMINATED

SYNTHANE

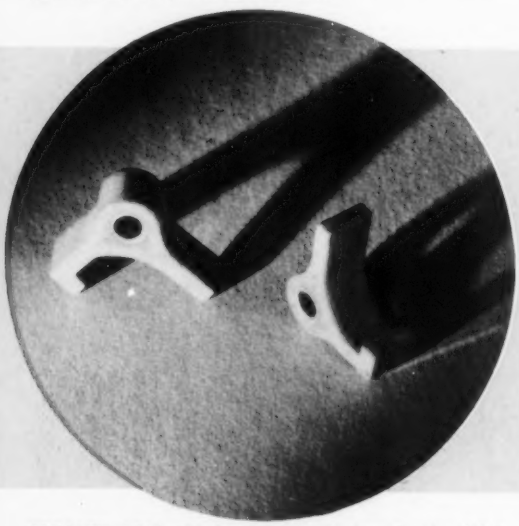
Plastics is a Word . . . like Metals



THRUST WASHER—Dimension stability, moisture resistance, compressive strength and immunity to oil are factors in the selection of Grade C (fabric reinforced) Synthane.



RADIO TERMINAL STRIP—Low power factor, low water absorption, low dielectric losses and stability of these properties led to the use of Synthane Grade XXXP.



BREAKER ARM—Synthane molded-laminated with a fabric filler is notable for its high impact strength, excellent wearing qualities and good electrical properties.

● **IT IS IMPORTANT TO AVOID** using the word "plastics" loosely or generically. It is as imperative to distinguish between plastics as between metals, say as between steel and bronze—and then to distinguish further between types of the same general plastics as you would between various steels and various bronzes.

● **SYNTHANE IS OUR NAME** for one type of plastics, made from phenol formaldehyde resins and various fillers. This type is thermosetting, that is, it does not soften under a reapplication of heat as do thermoplastic materials. The phenol formaldehydes, including Synthane laminated, are newsworthy among plastics for their *combination* of high tensile strength, high compressive strength, high flexural strength, high impact strength and high dielectric strength. Synthane has, of course, many other desirable properties in combination such as light weight, hardness, low thermal expansion, low moisture absorption, and resistance to corrosion.

● **THERE ARE, HOWEVER,** various grades of Synthane, just as there are various kinds of bronze, steel, aluminum, and other metals. Naturally, you will not find the optimum values of all properties combined in any one grade. For instance, one grade, reinforced with a paper filler, is most suitable for its mechanical characteristics, another for its dielectric qualities. In addition to paper grades there are grades reinforced with fabric, asbestos, and glass fillers and impregnated with a diversity of resins.

● **THE SELECTION OF A GRADE** of Synthane is influenced not only by its inherent physical, electrical, mechanical or chemical properties but often by processes of machining required to produce from Synthane the finished parts you require.

● **AS AN ILLUSTRATION,** production of the parts you have in mind may only be economical by punching. Depending on your requirements, paper base grades as XP, XXP or XXXP (the "P" denotes a punching or plasticized grade) may be amply adequate for your purpose.

● **USUALLY ONE OF THE MANY** standard grades of Synthane can be found to meet satisfactorily all your specifications, both in properties and in machinability. If not, we may have already developed, or have to develop, a special grade which will.

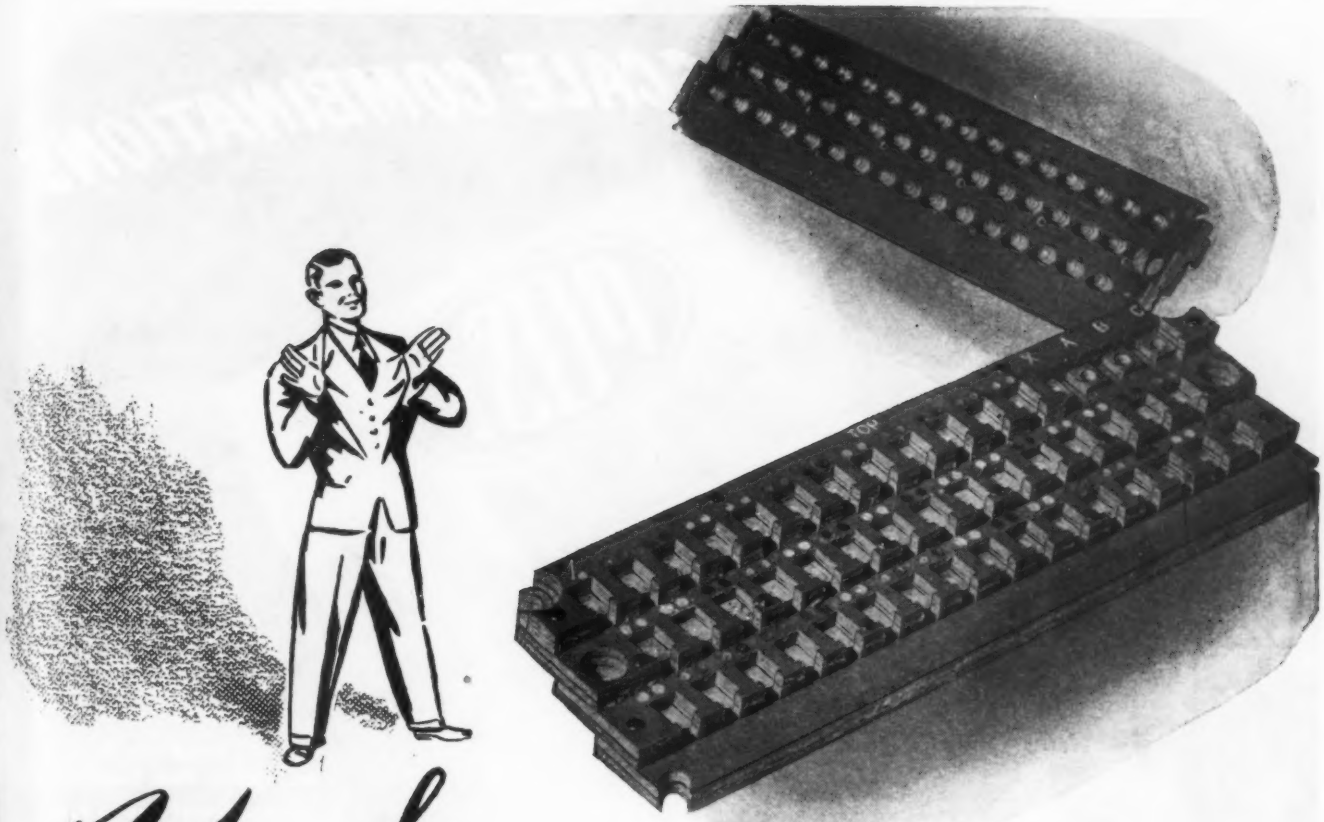
● **REMEMBER THAT SYNTHANE** is as adjustable within its combination of properties as an alloy of a metal, and that if you are not sure there's a grade of Synthane to fill the bill for you, just ask us. If possible, let us help you before you design and, in so doing, give us the opportunity to assist you in selecting the right Synthane material for your application and for ease in fabrication.

SYNTHANE

SYNTHANE CORPORATION, OAKS, PENNSYLVANIA

Representatives in All Principal Cities

PLAN YOUR PRESENT AND FUTURE PRODUCTS WITH SYNTHANE TECHNICAL PLASTICS · SHEETS · RODS · TUBES · FABRICATED PARTS · MOLDED-LAMINATED · MOLDED-MACERATED



Yes Sir— THAT'S OUR BABY!

What is it? Sorry, but that's a military secret! However, we can tell you this much—it's a very important and intricate part for a very important piece of equipment which is most important to the war effort. We're mighty proud of this particular job because it demonstrates our ability to cope with a situation which not only demanded *precision* in the fabrication of the component plastic parts but *hair-line accuracy* in assemblying those parts—*strictly according to specifications.* ★ True, all the parts we produce are not quite as complicated as this one but "extraordinary" or not, *every job* receives the same careful consideration right down to the last specific detail.

Send us Specifications for your next fabricated parts and let us prove to you that we can produce them *better...faster* and *more economically!*

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FABRICATORS, INC.
EAST ROCHESTER, N. Y.

Specification Fabricators of
VULCANIZED FIBRE, CORK, CORPRENE, PHENOL FIBRE, RUBBER, ASBESTOS AND OTHER MATERIALS

ONE PAD WITH 6 SCALE COMBINATIONS

Size 8½ x 11
No. 370 Tri-Post Designers Pad
75 sheets of Tracing Paper
6 Scale Combinations: inch, tenth, eighth, quarter, half—and isometric with eighth inch scale.
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Look to Shook for bronze bushings, flanged bushings, bored and solid bronze bars and all-service babbitts. They are fully described in Catalog 45. Write for it today!

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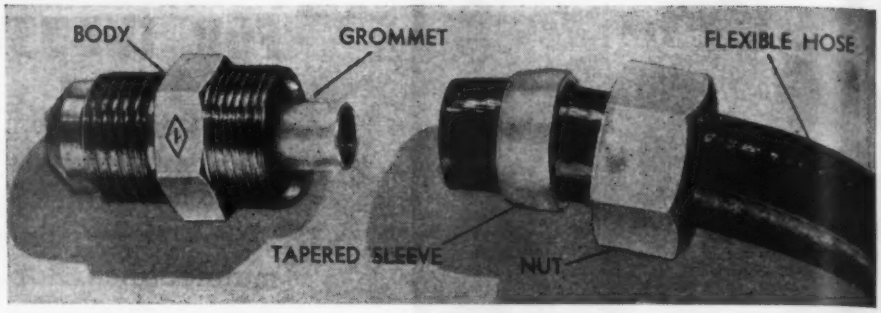
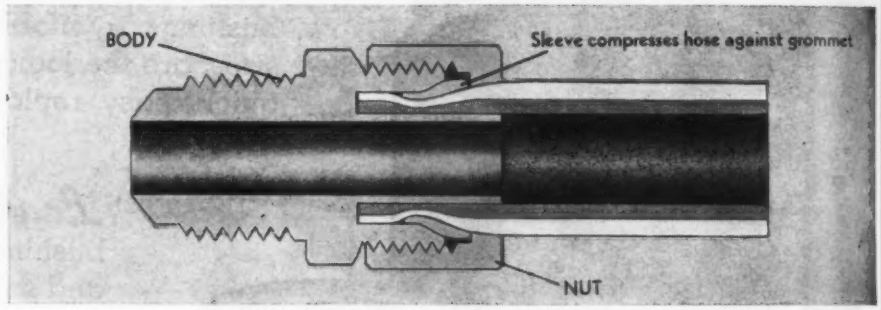
AN IMPERIAL DATA SHEET

Basic Data ON TUBING CONNECTIONS

NO. 6

FLEXIBLE HOSE COUPLINGS





HOW TO RECOGNIZE

Body can be identified by grommet extending from center of cavity. Sleeve is tapered in one direction only. Nut is similar to a compression nut except that seat for sleeve at bottom is square, not belled.

HOW TO ASSEMBLE

Cut off flexible hose squarely with ordinary cutting pliers. Pass hose through nut and sleeve, and push into body of fitting over grommet as far as it will go. Assemble nut to body and tighten as much as possible. Section diagram shows how hose is compressed between sleeve and grommet giving a tight, leakproof joint.

USED WITH SPECIAL HOSE

FN Fittings are designed specifically for use with Imperial FN Flexible Hose. (This is a special synthetic-lined, fabric-covered hose, finished with high luster, heat and oil resistant flexible lacquer. See additional data under ADVANTAGES.)

APPLICATIONS

Used for making up flexible gasoline, oil and grease lines for automobiles, trucks, power units, machinery, etc. Especially adapted for installation and replacement work, or where only a limited number of lines of a given type are needed. When flexible lines of a given specification are required in quantity, Imperial Flexible Hose Assemblies made up exactly to your requirements with fittings attached should be specified.

ADVANTAGES

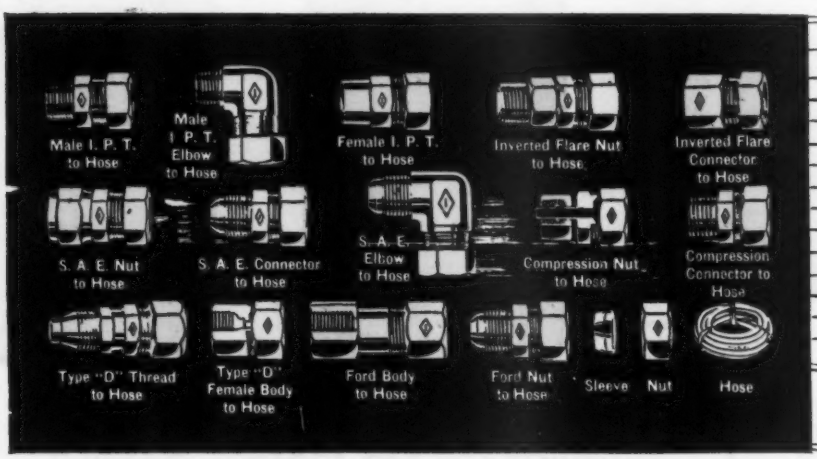
Makes it simple to make up any desired flexible gasoline, oil or grease line in a few moments. Hose is supplied in 25-foot coils and can be cut to any needed length. A wide range of attachable fittings are available which give any desired type of end connection.

Hose is strong, durable and will withstand severe twisting and bending. Has oil and gasoline proof synthetic lining. Has working capacity of 150 to 300 lbs. per sq. in. depending on size.

STOCK SIZES AND TYPES

Couplings have one end for connecting to flexible hose; other end can be furnished in the standard types and sizes of connections shown in the table below.

THE IMPERIAL BRASS MANUFACTURING CO., 515 So. Racine Ave., Chicago 7, Illinois


Male I. P. T. to Hose
Male I. P. T. Elbow to Hose
Female I. P. T. to Hose
Inverted Flare Nut to Hose
Inverted Flare Connector to Hose
S. A. E. Nut to Hose
S. A. E. Connector to Hose
S. A. E. Elbow to Hose
Compression Nut to Hose
Compression Connector to Hose
Type "D" Thread to Hose
Type "D" Female Body to Hose
Ford Body to Hose
Ford Nut to Hose
Sleeve
Nut
Hose

Fitting Types and Sizes

Type of Connection	Sizes
Male I.P.T.	1/8" to 1/2" I.P.T.
Male I.P.T. Elbow	1/8" to 1/2" I.P.T.
Female I.P.T.	1/8" to 1/2" I.P.T.
Inverted Flare Nut	3/16" to 1/2" O.D.
Inverted Flare Connector	3/16" to 1/2" O.D.
S.A.E. Nut	3/16" to 1/2" O.D.
S.A.E. Connector	1/4" to 1/2" O.D.
S.A.E. Elbow	1/4" to 1/2" O.D.
Compression Nut	3/16" to 5/16" O.D.
Compression Connector	1/4" to 1/2" O.D.
Type "D" Thread	3/16" to 5/16" O.D.
Type "D" Female Body	1/8" to 3/8" O.D.
Ford Body	1/4" O.D.
Ford Nut	1/4" O.D.

Flexible Hose Sizes

Hose is available in sizes equivalent to 1/4", 5/16", 3/8" and 1/2" O.D. Copper Tubing.

IMPERIAL

★ *Headquarters for tube fittings and tube working tools*

Reprints of this page will be sent on request

● Its *bend-ability* and high arc resistance, suggested the use of National Vulcanized Fibre in the manufacture of this arc baffle used in an electric circuit breaker.

Tough Production Problems Made Easy by this Remarkable Property of National Vulcanized Fibre

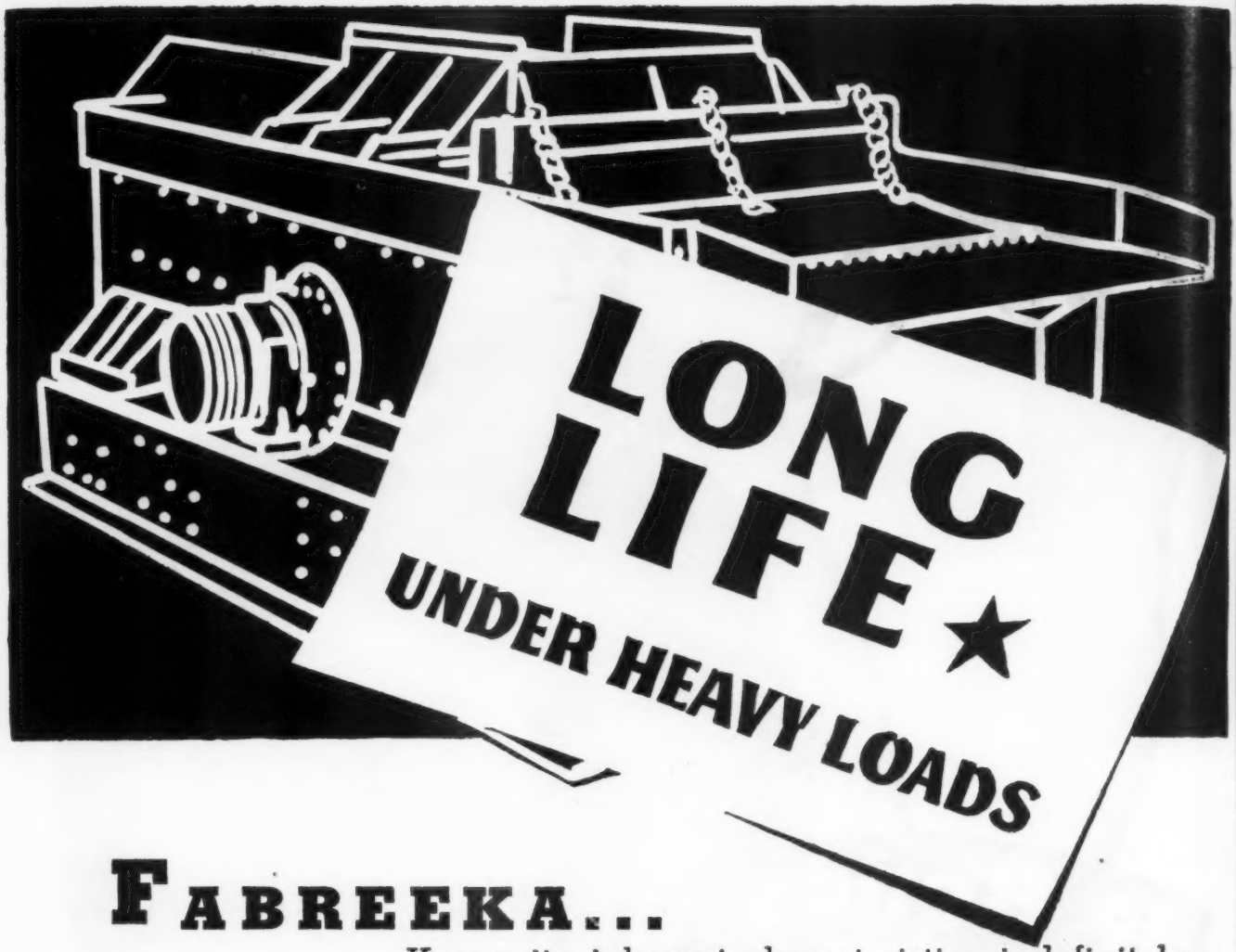
Just as the amazing bending properties of National Vulcanized Fibre suggested its use and simplified the production of this arc baffle—so will its combination of outstanding characteristics make it readily adaptable for the manufacture of countless other industrial products.

Its superior machinability and forming qualities, its toughness and high dielectric strength, its resistance to wear and abrasion, its lightness of weight and its long-lasting durability . . . all combine to make this material highly versatile and suitable for an almost endless number of industrial uses. If desired, these same properties may be modified to meet requirements of your specific applications.

Right now our entire output is being used for vital war purposes. But our technical engineers will be glad to work with you and show you how this versatile material will help you overcome tough production problems in peacetime . . . how it may open up entirely new fields for profitable products for you. Write us *now*. Let a trained technical man show you how National Vulcanized Fibre will help you *later on*.

NATIONAL VULCANIZED FIBRE CO.

Wilmington, Delaware — *Offices in Principal Cities*



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Keeps its inherent characteristics indefinitely. It does not break down in service under heavy loads . . . This means fewer shut-downs and tear-downs of machinery for overhaul and repair — with consequent low maintenance costs and high production efficiency.

Product Engineers and Machine Designers are turning to FABREEKA to solve many problems in the absorption of impact shock and the isolation of transmitted vibration. Write for our Engineering Book: Fabreeka for Impact Shock, Vibration and Noise.

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1 Limited Resiliency
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3 Minimum "Permanent Set"
4 Great Strength
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In the design and manufacture of your products

KOPP *Engineered Glass*

OFFERS THESE ADVANTAGES:

LONGER LIFE. Because Kopp *Engineered* Glass successfully withstands destructive forces such as corrosion, abrasion, heat, aging—products in which it is used have *longer life.*

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ECONOMICAL. In addition to the economy of longer life and better service, Kopp *Engineered* Glass often permits the introduction of assembly or manufacturing economies that effect worthwhile savings.

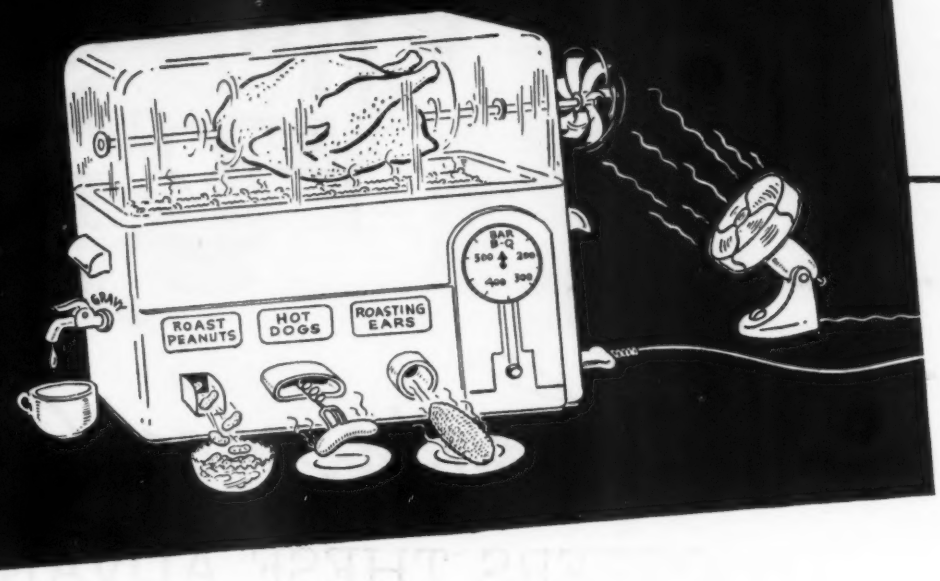
CONTROL OF LIGHT. If light control is a function of the glass you use, Kopp has a wealth of experience on this subject to place at your disposal. The transmission of infra red and ultra violet rays, beam control for concentration or diffusion, accurate color transmission; these are some of our specialties.

Write for the informative booklet "Looking at Engineering Problems Through Glass."

KOPP GLASS INC.

SWISSVALE, PENNSYLVANIA

Designers may disagree about
"SUPPLEMENTARY FEATURES"



. . . but they all know an ELECTRIC ROASTER MUST HAVE GOOD INSULATION

Electric Roasters, like modern Electric Ranges, have done much to demonstrate the value of good thermal insulation. Both use "stored heat" to do much of the cooking, making possible greater efficiency and lower operating costs.

Naturally, good insulation in an Electric Roaster pays handsome dividends to all concerned. Homemakers appreciate *operating economy* in their roasters. They also appreciate *uniform* cooking results . . . and a *cool* kitchen. This, in turn, makes for satisfied customers, the biggest asset that any retailer or manufacturer can have.

Fiberglas* Insulating Wool, Type TW-F, has long been the outstanding insulation for Electric Roasters. High in insulating qualities, inorganic *Fiberglas* is clean, chemically stable, immune to moisture, is odorless and does not absorb odors. It is light in weight (important in roasters). It is also resilient—doesn't settle or pack down. This resiliency permits installation at any density to meet specific requirements for thermal efficiency.

Yes, Fiberglas is an efficient "lifetime" insulation. If you're thinking about Electric Roasters (or similar Household Equipment) for early postwar production, Fiberglas Insulation deserves a place in your plans.

For full details regarding Fiberglas Insulation, write *Owens-Corning Fiberglas Corporation, 1850 Nicholas Building, Toledo 1, Ohio. In Canada, Fiberglas Canada Ltd., Oshawa, Ont.*

ARMY E NAVY

FIBERGLAS THERMAL INSULATION

*T. M. Reg. U. S. Pat. Off.

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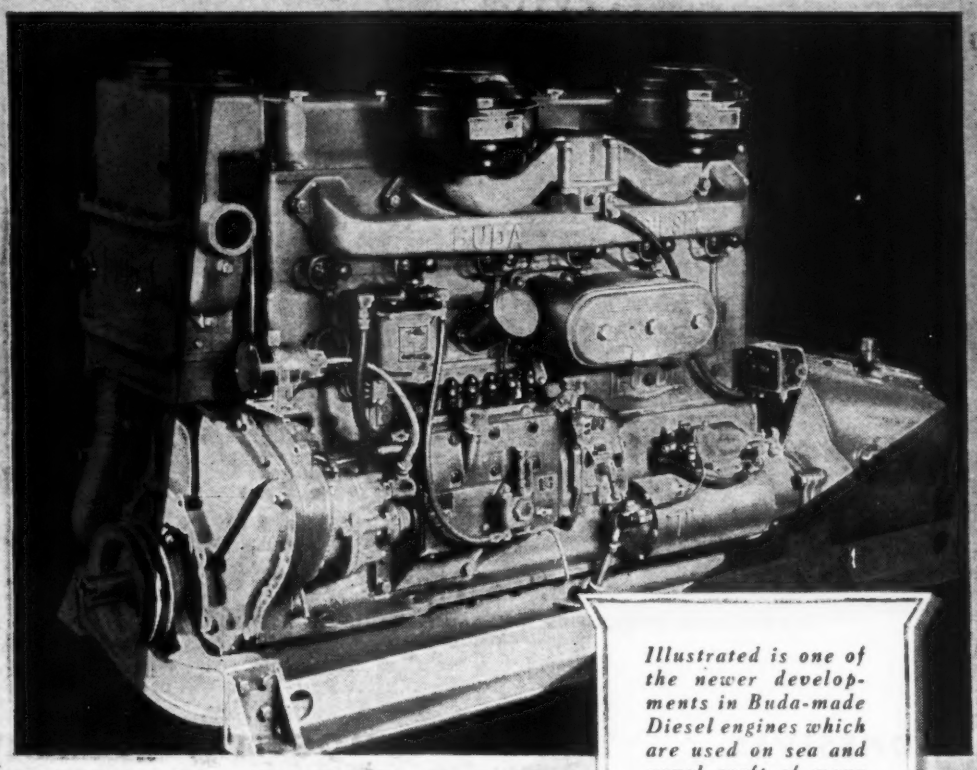

Illustrated is one of the newer developments in Buda-made Diesel engines which are used on sea and naval craft of many types; also land based power units and industrial equipment.

Diesels by Buda-- Dressed by Lowe Brothers

Internationally known maker of Diesel engines and other important equipment is the Buda Company of Harvey, Illinois, whose products are providing efficient power so vital to both military and industrial use.

For many years Buda motors and hoods have been finished with a spray applied air drying coating supplied by Lowe Brothers. It is required to provide protection against a wide variety of climatic conditions.

Like Buda, many other makers of important industrial equipment know that Lowe Brothers finishes are the product of intensive and continuing research in both the laboratory and the field. This type of study coupled with high manufacturing standards assures the right product for many varying and exacting work and exposure conditions.

No matter what your finishing problem involves—resistance to cutting compounds, greases, alkalis or other specific conditions—you can count on Lowe Brothers experience to help you solve it. Your request for advice involves no obligation.

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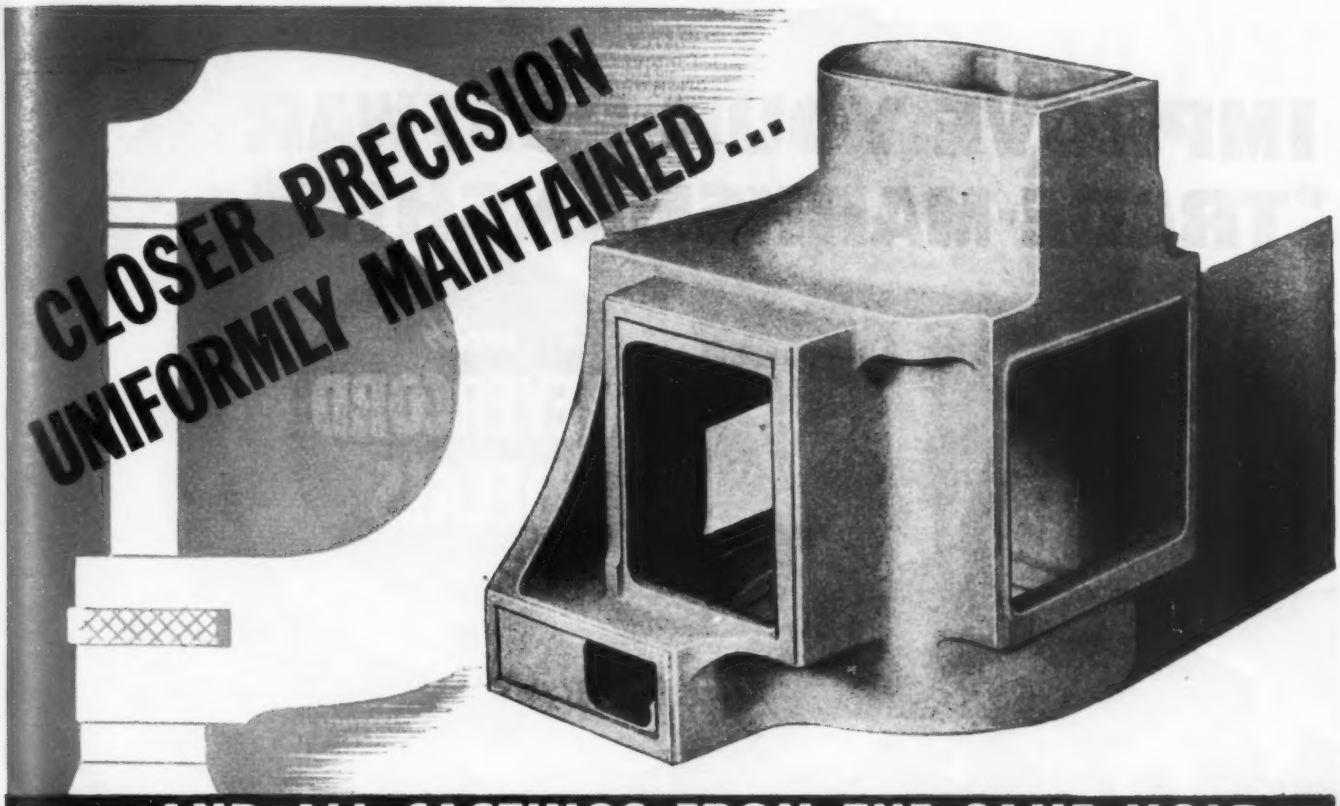

. . . AND ALL CASTINGS FROM THE SAME MOLD

When your castings are made by the permanent mold technique, you may be sure of the utmost precision in following your design. For the permanent **metal** mold operates with a dimensional tolerance of only ± .010", compared to ± .030" in sand casting.

And this precision is uniformly maintained, no matter how many castings are poured. For, as the same molds are used regardless of the number of castings poured, there is no opportunity for dimensions to vary. **Right** in the first place, these castings **stay right** all through the run. Metal surfaces also promote rapid cooling, with finer grain and greater tensile strength.

Aluminum Industries has had nearly 25 years' experience in the making of permanent mold aluminum castings. We know of no foundry with better facilities or more modern equipment. And to our casting "know how" we add a thorough knowledge of aluminum and its alloys.

One of our technical representatives will be glad to visit your plant and demonstrate how permanent mold castings cut down finishing time and costs. And remember – Permite permanent mold castings may be just what you are looking for to get the jump on competition in the postwar world. Consult us regarding your requirements.

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PERMITE ALUMINUM ALLOY CASTINGS

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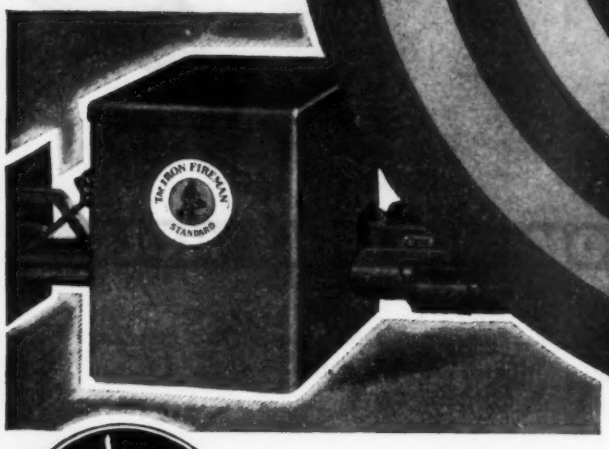
with
MEYERCORD DECALS



Score a *BULLS-EYE* in Low-cost, LASTING IDENTIFICATION

Your postwar product deserves a fine trademark...a lasting form of identification that continuously tells "who made it" for the life of the product. Meyercord Decals, combat-tested on world battle fronts, provide the ideal trademark or nameplate. They're durable, washable, and resistant to acid, vibration and temperature extremes. They can be produced in any size, colors or design and applied at fast production line speeds. No rivets, bolts or screws required. Easy-to-use methods of adhesion permit fast, lasting application to any known *commercial surface.* Investigate the better "Trademarksmanship" of Meyercord Decals. Free designing and technical service is at your disposal. Write for literature. Address all inquiries to Department 16-4.

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RUFKAST Goes to War on Instrument Panels

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...Large, Medium and Fine Wrinkle

Speed up war production with this new, improved Berry Brothers' Rufkast. Quick baking means more production. Strong wrinkling action protects it against shiners—results in fewer rejects. Non-glaring surface cuts down eye strain—makes the fine-pattern-dull an ideal finish for instrument panels.

Use Berry Brothers' Rufkast as a time-saving finish on radio and radar equipment.

All three patterns—large, medium and fine—can be baked with infra red equipment, as well as in gas or electric ovens. All wrinkle properly, even under high initial heat. Edges and corners wrinkle uniformly, and hardening of film continues after baking, due to oxidation of drying oil.

Infra red baking time depends upon weight of metal, but 10 minutes with 250 watt lamps is usually sufficient. Gas or electric oven baking is one hour at 250-275°.

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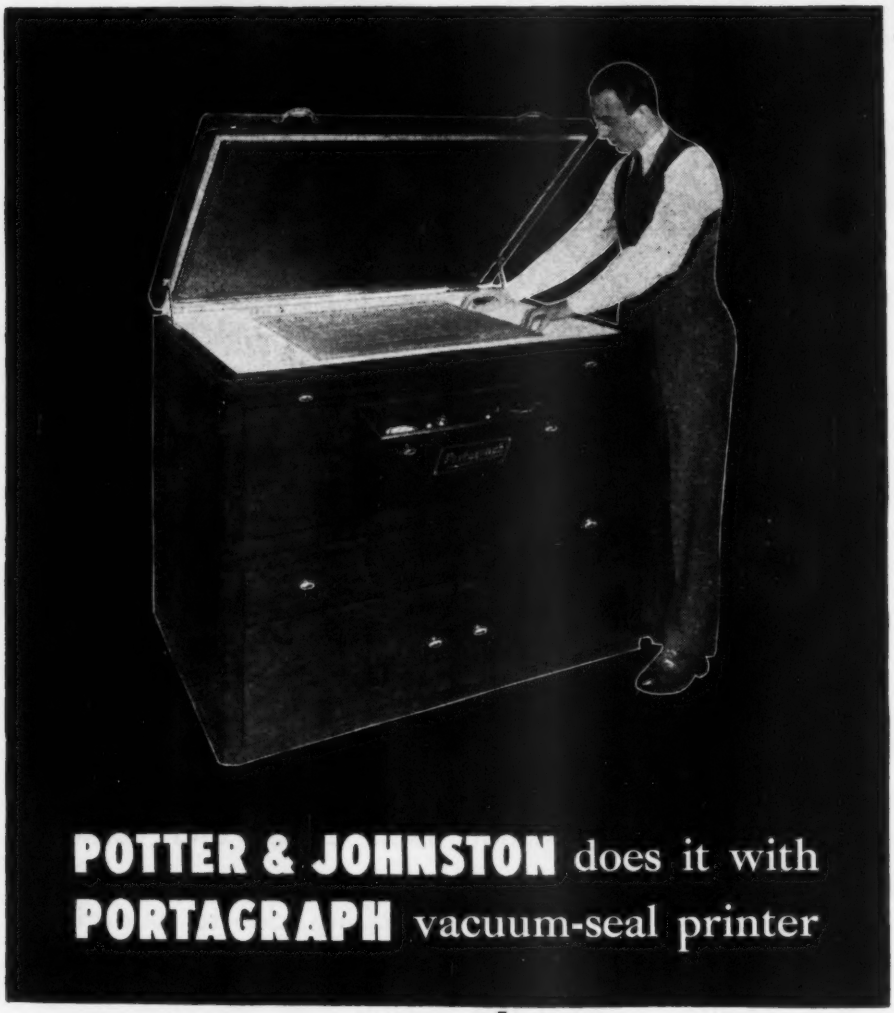


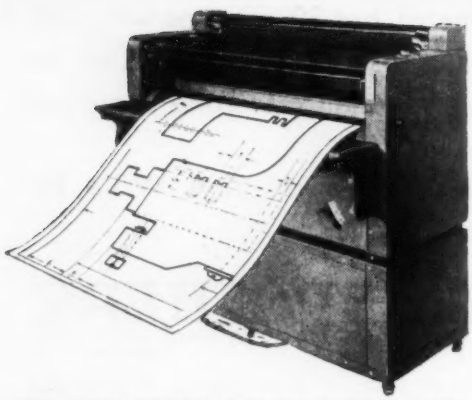
POTTER & JOHNSTON does it with **PORTAGRAPH** vacuum-seal printer

Ninety percent in time and economy is exactly what the Potter & Johnston Machine Co. of Pawtucket, R. I., gained when they installed their Portagraph.

Their problem was one common to the engineering profession today —tremendously increased demands on the drafting room concurrent with war-reduced manpower.

"Some of our machine tracings require 80 to 90 hours' drawing time", states Harold B. Soule, Assistant Chief Engineer. "The slightest revisions meant 40 to 50 hours for complete tracings. Portagraph reduced this operation to 4 or 5 hours, stepping up production in these busy times ten to one."

Using the 40" x 60" Vacuum-Seal Portagraph, — available also in 30" x 40" size — Potter & Johnston immediately discovered another great time-saving. Eliminated were the hour-consuming checkings for accuracy with Portagraph's speedy reproduction of ink-like photocopies of anything written, printed or drawn. "It's surprising", Mr. Soule says, "how much clearer Portagraph copies are than the originals when we work from old worn tracings, transforming them into featherweight paper positives for blue printing by means of Portagraph reverse negatives."



THE CONTINUOUS ROTARY PORTAGRAPH is ideal when original drawings larger than the capacity of Vacuum-Seal Portagraphs are needed. Produces copies from originals as wide as 42" and of unlimited length with continuous rotary operation. It excels in reproducing drawings, tracings, maps, blueprints, or other large volume copying.

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American industry has been quick to utilize the new Dow Corning Silicones—to see the potentialities inherent in their higher order of heat stability, chemical inertness, water resistance, and dielectric properties. Dow Corning is now supplying, directly or through selected distributors, the following silicone products:

DC FLUIDS Water-white, odorless, inert Silicone Liquids . . . notable for their low rate of viscosity change over a wide temperature range, low vapor pressure, water repellency, and good dielectric properties.

DC 4 Ignition Sealing Compound . . . an easily applied silicone waterproofing compound having excellent dielectric properties, corona resistance, and the consistency of petroleum jelly. It neither hardens nor melts at temperatures ranging from −40° F. to 400° F.

DC 7 Special Low Temperature Compound . . . an oxidation resistant lubricant and sealing compound developed for use at temperatures as low as −70° F.

DC 31 A lubricating Silicone Grease for special applications in the temperature range of −70° F. to 190° F.

DC 41 A lubricating Silicone Grease for special applications where operating temperatures range from 0° F. to 400° F.

DC 993 Insulating Varnish . . . recommended because of its extreme heat stability for impregnating, coating and bonding, and waterproofing inorganic insulating materials such as asbestos, mica, and Fiberglas cloth, tape, and sleeving. Other special purpose silicone resins and compounds are available.

DC STOPCOCK GREASE A chemically resistant Silicone Grease for lubricating stopcocks and other ground glass joints.

DC PLUG COCK GREASE A Silicone Grease that affords easy operation of lubricated plug valves over wide temperature ranges in most difficult services.

DOW CORNING CORPORATION
MIDLAND, MICHIGAN
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FIRST IN SILICONES

WILL IT RUST?

MOLTEN ZINC—applied by the Hot-Dip Galvanizing Process—provides the greatest possible protective coating against rust. A positive bond between coating and base metal is the result of the high temperatures employed in the Hot-Dip Method. The definite fusion of the two metals means longer life and service. Thousands of installations—their life increased twenty to forty years—are testimony to savings of millions of dollars in costly maintenance and replacement.

No guesswork in the Hot-Dip Process! Years of experience in laboratory and field have proved the rust prevention value of Hot-Dip Galvanizing. It is *most* economical and *dependable*.

If your products or installations are exposed to conditions that cause corrosion—let us tell you how Hot-Dip Galvanizing will extend their life and save you money. Write today. American Hot-Dip Galvanizers Association, Inc., First National Bank Building, Pittsburgh 22, Penna.

"If it carries this seal it's a job well done."

Buy from the qualified members listed below and KNOW you are getting a genuine HOT-DIP job.

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MARYLAND
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Here's experience, skilled engineers and workmen, modern equipment and good management to assure precision work for your tube-bending problems and prompt deliveries.

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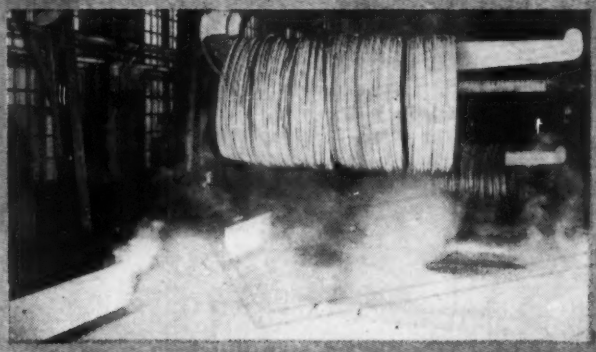

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FOR PROFIT-MINDED FABRICATORS

IF YOU'RE A FABRICATOR of round, flat, shaped wire; or strip steel up to 10 inches—turn to Roebling for your materials. You'll find your men, machines, methods work better—more profitably, too.

When you specify, "wire from Roebling", the steel analysis and grain structure is closely controlled. The tensile strength, dimensional accuracy and ductility will comply precisely with your most exacting requirements.

Roebling strip steel is now available in widths up to 10 inches. In forming, punching, shearing, drawing it often adds efficiency to these operations.

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STRIP STEEL

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• You can get much useful information on the physical properties of the high-strength cold-rolled austenitic alloy steels by writing for the technical publications listed below.

All these papers are based on studies made at the research laboratories of Electro Metallurgical Company, and are part of a broad development program to find new or improved ways of using stainless and other alloy steels and irons.

Buy United States War Bonds and Stamps

"The Stress-Strain Characteristics of Cold-Rolled Austenitic Stainless Steels in Compression as Determined by the Cylinder Test Method" — describes a method for determining compressive strength of thin sheets of these steels; it is illustrated by curves from the tests on typical grades of stainless steel.

"Effects of Low-Temperature Heat-Treatment on Elastic Properties of Cold-Rolled Austenitic Stainless Steels" — a 16-page paper, illustrated by charts and graphs, on the results of various low-temperature heat-treatments on the mechanical properties of cold-rolled austenitic stainless steels.

"High-Manganese Austenitic Steels" — physical data on new high-strength steel, for possible use in aircraft construction and in other lightweight structures.

"Tension and Compression Stress-Strain Characteristics of Cold-Rolled Austenitic Chromium-Nickel and Chromium-Manganese-Nickel Stainless Steels" — a compilation of important physical data on austenitic chromium-nickel and chromium-manganese-nickel steels.

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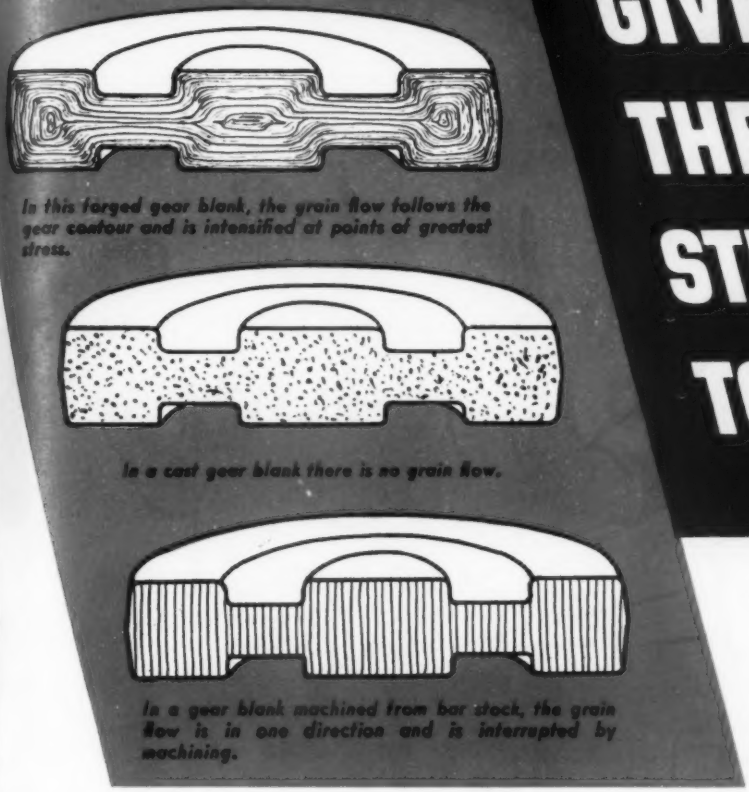
Why FORGING GIVES METALS THEIR ULTIMATE STRENGTH and TOUGHNESS



In this forged gear blank, the grain flow follows the gear contour and is intensified at points of greatest stress.

In a cast gear blank there is no grain flow.

In a gear blank machined from bar stock, the grain flow is in one direction and is interrupted by machining.

The sketches portray the fundamental character of forgings as compared with parts produced by other methods. Only in forgings will you find the tough fibrous grain structure, with the grain flow advantageously directed throughout the piece, and the fibre structure concentrated at the points of greatest shock and stress.

Here is the "secret," known to hammersmiths for hundreds of years, of the far greater resistance of forgings to tensional and torsional stresses. As forgings are metal in an intensely compressed state, they are likewise highly resistant to compression and impact. Forged parts also rank high in fatigue resistance and useful life. Measured in service per dollar expended, forgings are economical.

For the advanced, speedier and more trouble-free machines of tomorrow, a broader use of forged parts is definitely indicated. Forgings provide important savings in weight because parts of smaller sectional thickness may be safely used. Forgings require a minimum of machining, and the forging process eliminates internal defects which might cause sudden breakdown or failure.

When you need flat die, drop or upset forgings, let our more than a hundred years of experience help you as it has hundreds of aircraft and ordnance builders during the war era.

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PARCO LUBRIZING
Protects Moving Parts from Scoring, Hastens Break-in

Parco Lubrizing not only protects against wear but also provides rust resistance.

Parco Lubrizing assures longer life to moving parts, contributes to smooth, efficient operation, and stretches the time between reconditioning jobs.

Pistons, piston rings, cylinder liners, valve tappets and camshafts are just a few of the many parts that are now being Parco Lubrized in regular production. Never put two bare metal parts in contact in any machine assembly where wear is a factor.

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Parco Lubrizing is a simple, inexpensive chemical treatment, that produces on bearing surfaces of iron and steel, without the use of electric current, a nonmetallic, oil absorbent coating that permits rapid break-in of moving parts without scoring or scuffing and reduces subsequent wear.

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This valuable book—just off the press—tells you how to select the proper quality, weight, thickness, shape and size of felt to fit any particular requirement; how easily to order cut felt parts with complete assurance that your parts will be promptly and accurately supplied. Send for this book today and learn why it is decidedly to your advantage to order cut felt parts from the company which controls *every* step in felt manufacture right from the combing of the wool.

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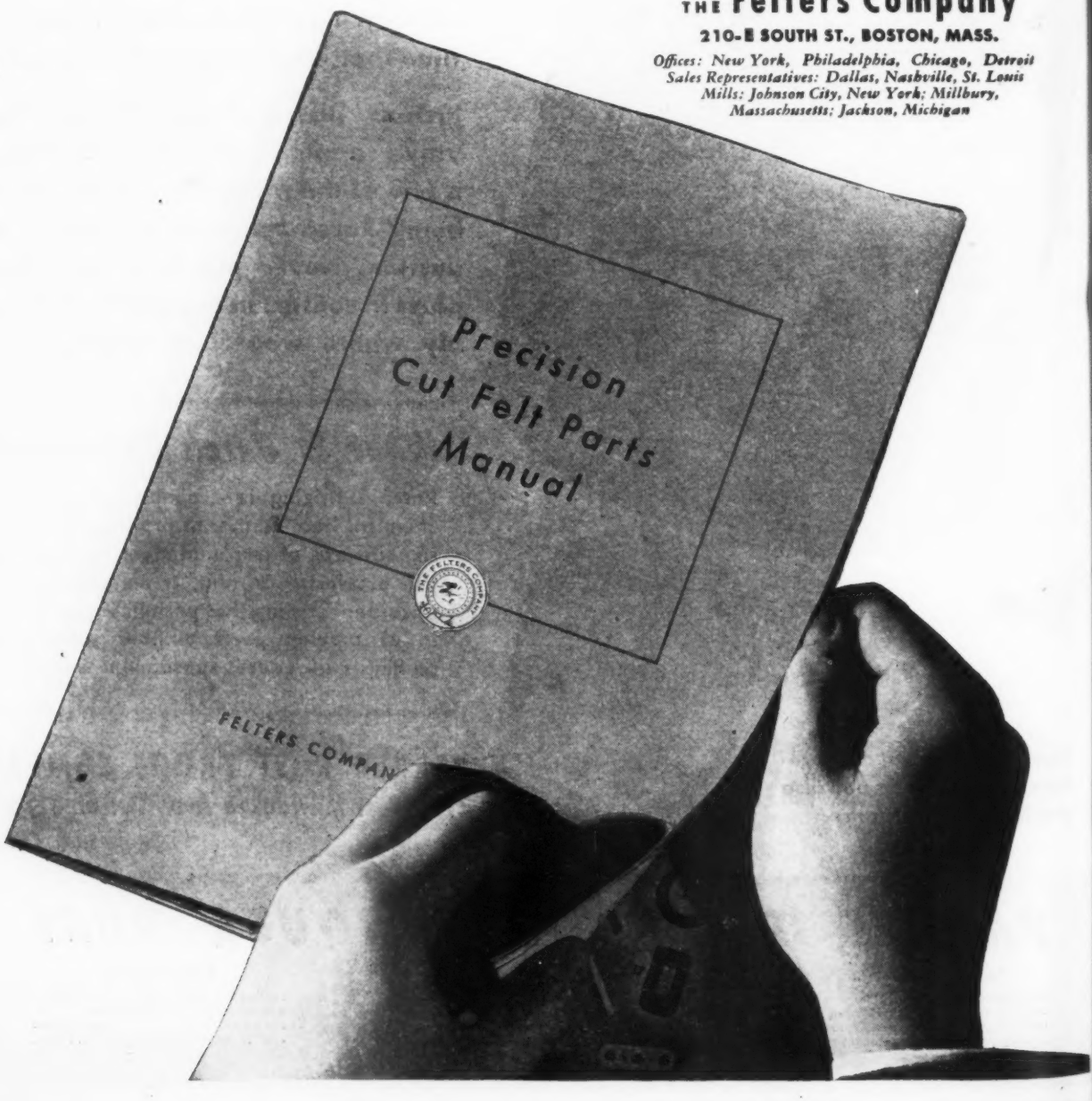

Final inspection — Micrometer indicators used to determine accuracy of machining of PANELYTE Barrel Support Block to assure exact tolerances.

"Hair Trigger" accuracy of

PANELYTE*

PRECISION-FABRICATION SHOWN IN HAMILTON PROPELLER BLOCKS!

Vertical milling of 3" and ¾" radii on PANELYTE Barrel Support Block, milled to tolerance of ±.001" as curved surface must exactly fit inside contour of barrel.

The straight-line mass production of PANELYTE Barrel Support Blocks demands no less than 12 different machining operations. Manufactured for the Hamilton Standard Propeller for bomber and combat planes, this intricate part aligns and supports the controllable pitch mechanism, in relation to the housing. The slightest variation in any machining operation would result in faulty propeller performance.

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Why not take advantage of the extensive, first-hand experience of the Panelyte Engineering Staff in designing, developing and producing fabricated and molded structural parts?

Barrel Support Block of fabric base PANELYTE — Note complex design of part, 3 different size holes, and milled seat and milled oil groove.

PANELYTE — *the structural plastic*

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The attractive Ls housing of the Recordagage leaves all parts of the complex instrument readily accessible.

Beauty THAT'S MORE THAN SKIN DEEP

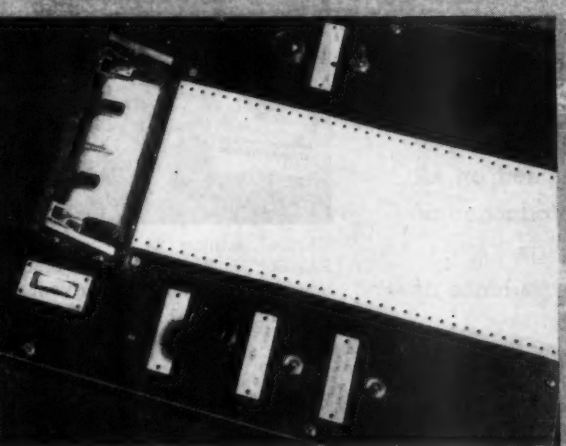
Electronically operated Recordagage is supported, protected, and attractively housed by its sturdy Ls cabinet

The Physicists Research Company, builders of the electronic displacement charting device called the Recordagage, chose Lindsay Structure for the housing for other advantages as well as for its attractiveness.

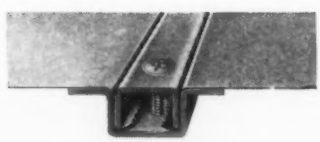
Equipment housed in sturdy Lindsay Structure is protected against dirt, moisture, and mechanical damage. The die-formed parts for Ls fit snugly together; Ls units, utilizing the principle of uniform tensioning, are rigid and vibration-proof.

The unique high strength-weight ratio of Lindsay Structure saves space and weight in any of its thousands of applications. No heavy, bulky diagonals, gussets, or struts are necessary. Quickly and easily assembled, this modern method of light metal construction requires no retooling, trimming, fitting, welding, or riveting for its erection.

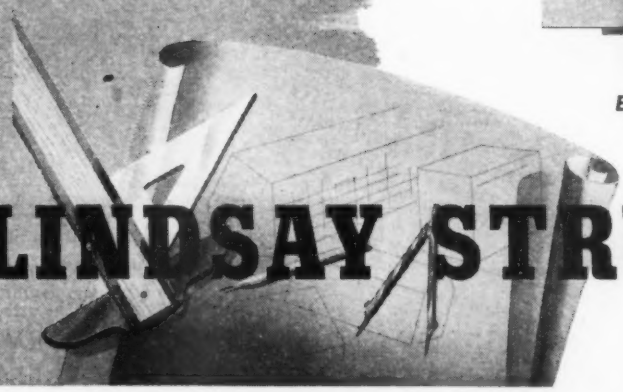
Investigate the advantages of Ls when applied to your product. Write to **Lindsay and Lindsay, 222-B W. Adams St., Chicago 6, Ill.; to 60 E. 42nd St., New York 17, N. Y.; or to Lindsay Structure (Canada) Ltd., Dominion Square Bldg., Montreal.**



Top panel of the Recordagage. Panel is of black bakelite and is mounted directly to the Ls.



Easy to assemble



Ls

LINDSAY STRUCTURE

U. S. Patents 2017629, 2263510, 2263511
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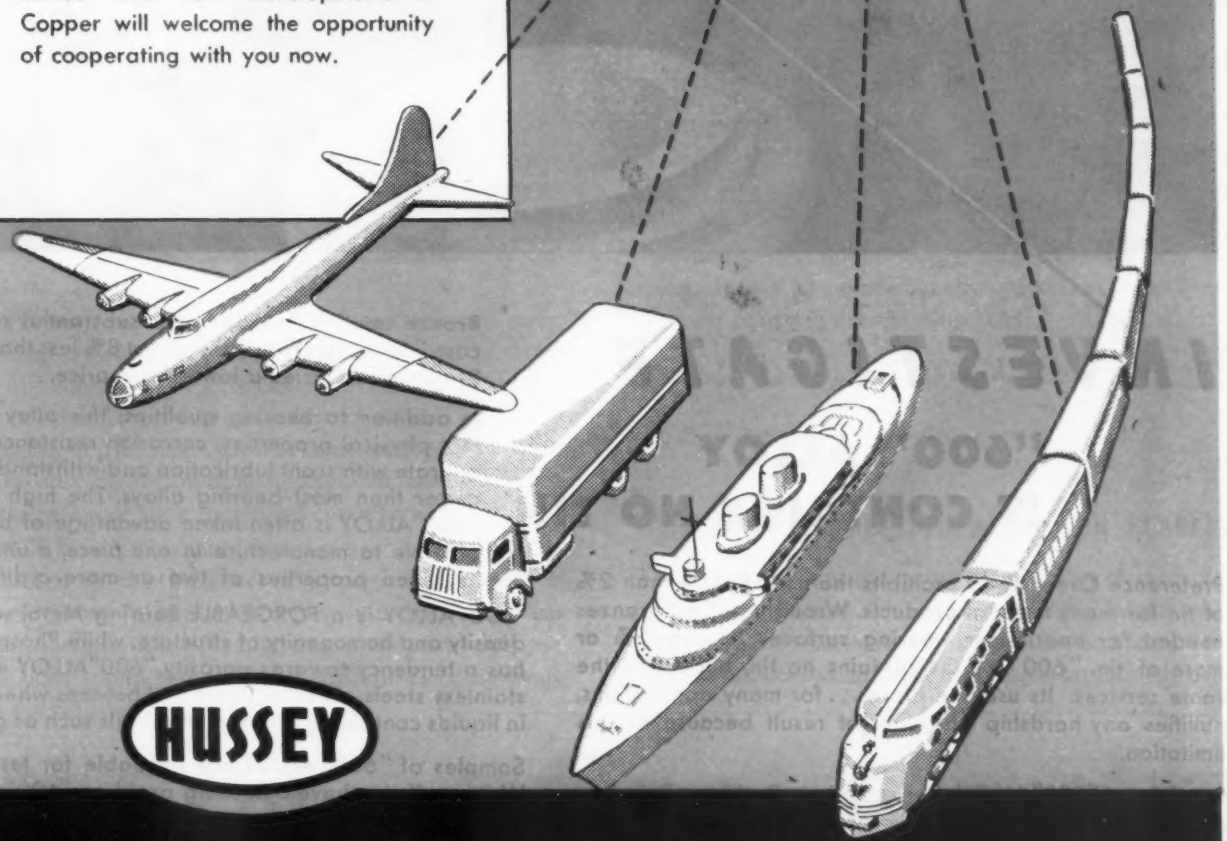
In the post war era, wherever man travels, or world trade brings prosperity—there you will find Copper doing the jobs that no other metal can equal. There too, will be proven again, the superiority and outstanding dependability of Hussey Copper and Copper products. Hussey engineers armed with new developments in Copper will welcome the opportunity of cooperating with you now.



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INVESTIGATE

"600" ALLOY
IT CONTAINS NO TIN

Preference Order M-43 prohibits the use of more than 2% of tin for many types of products. Wrought or Cast Bronzes needed for bearing or wearing surfaces require 5% or more of tin. "600" ALLOY contains no tin, but fulfills the same services. Its use, therefore . . . for many applications, nullifies any hardship which might result because of this limitation.

Bearings of "600" ALLOY, Gears, Pinions, Bushings, Spindles, and many other parts, have successfully replaced Phosphor Bronze applications, and at a substantial reduction in cost. "600" ALLOY weighs about 8% less than Phosphor Bronze and carries a lower base price.

In addition to bearing qualities, this alloy has excellent physical properties, corrosion resistance, ability to operate with scant lubrication and withstands abrasives better than most bearing alloys. The high strength of "600" ALLOY is often taken advantage of because it is possible to manufacture in one piece, a unit requiring the combined properties of two or more ordinary alloys.

"600" ALLOY is a FORGEABLE Bearing Metal which has a density and homogenity of structure, while Phosphor Bronze has a tendency towards porosity. "600" ALLOY will outwear stainless steels, nitrided steels and bronzes when operating in liquids containing abrasive materials such as grit or sand.

Samples of "600" ALLOY are available for test purposes. Write us if you have a bearing problem. "600" ALLOY may be the very solution.

MUELLER BRASS CO.
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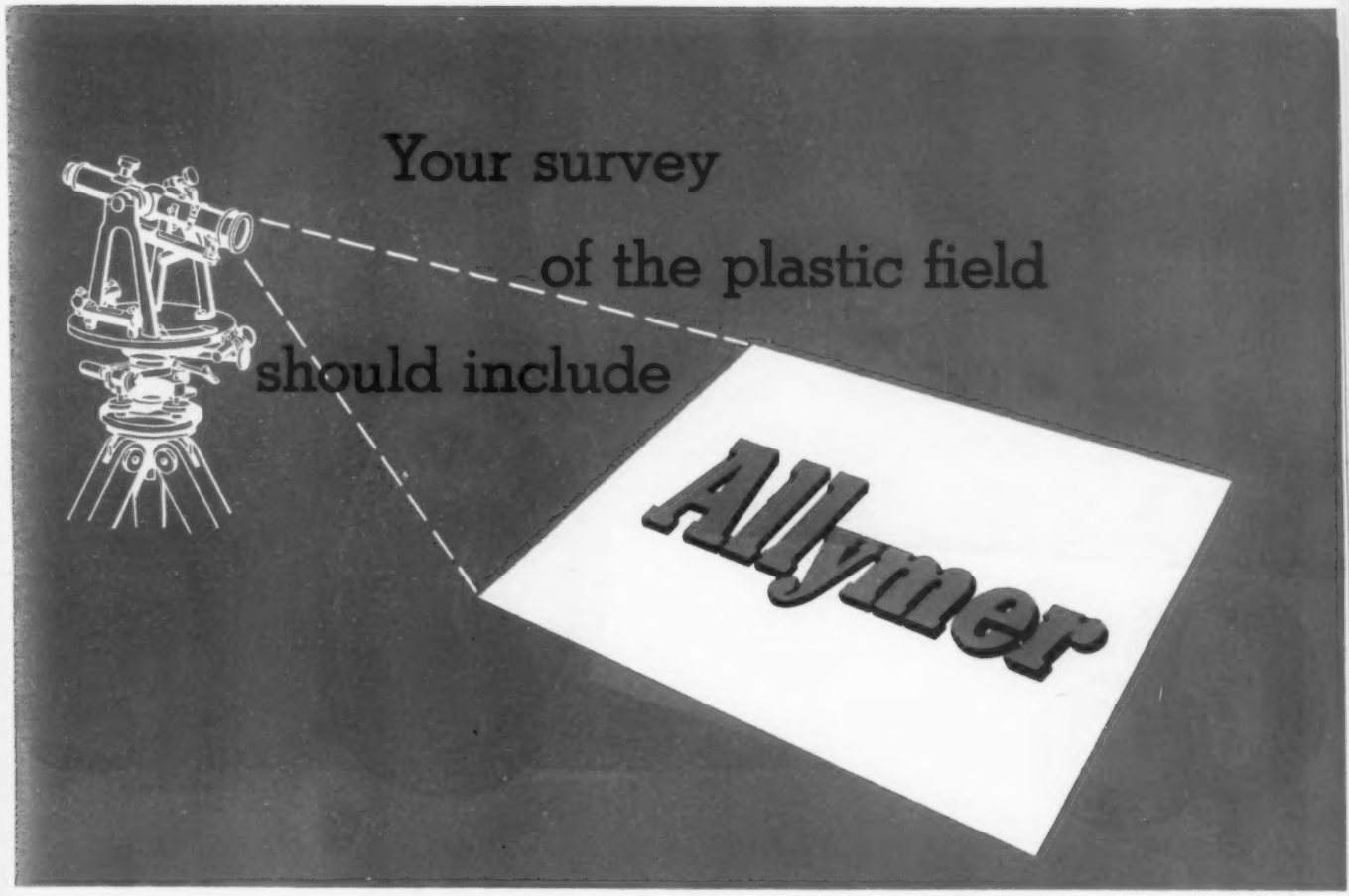


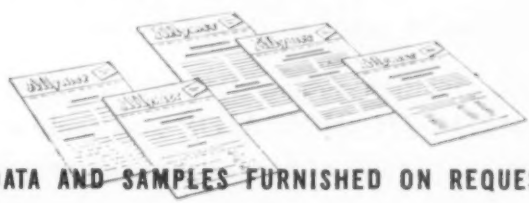
Still new—but proved in important wartime applications—Columbia's Allymers merit consideration for products requiring crystal-clear castings or high-strength laminations. In the three basic Allymer types—or their modifications—you may find the material which precisely meets your production needs for direct polymerization, laminates, or for copolymers.

The Allymers are thermosetting, contact-pressure monomers which can be stored for relatively long periods without the use of inhibitors. They are easily handled and evolve no gaseous or other by-products in polymerization. They are—depending upon the type—either non-irritating to the skin or require only slight care to avoid skin irritation. Here is a brief description of their individual characteristics:

Allymer CR 39—A monomeric liquid of low volatility which, when heated in the presence of a peroxide catalyst, is transformed into a hard, insoluble, infusible, glass-clear solid. It affords an unusually high degree of optical clarity—89-92% light transmission per ¼" thickness. Also available in sheets, rods and tubes.

Allymer CR 149—a crystalline monomer which, with gentle warming, becomes a viscous liquid and on exposure to a peroxide catalyst with heat, assumes a structure similar to Allymer CR 39. Especially desirable for laminated products where high strength and lightness of weight are essential.

Allymer 170—A liquid monomer, noteworthy for faster curing. It may be modified in any proportion with the other Allymers to attain desired properties.



DATA AND SAMPLES FURNISHED ON REQUEST

Comprehensive data and reports of extensive research will be provided on request. Though not essential, a statement of your intended use will be helpful in supplying specific information desired and samples appropriate for experiment.

COLUMBIA CHEMICALS

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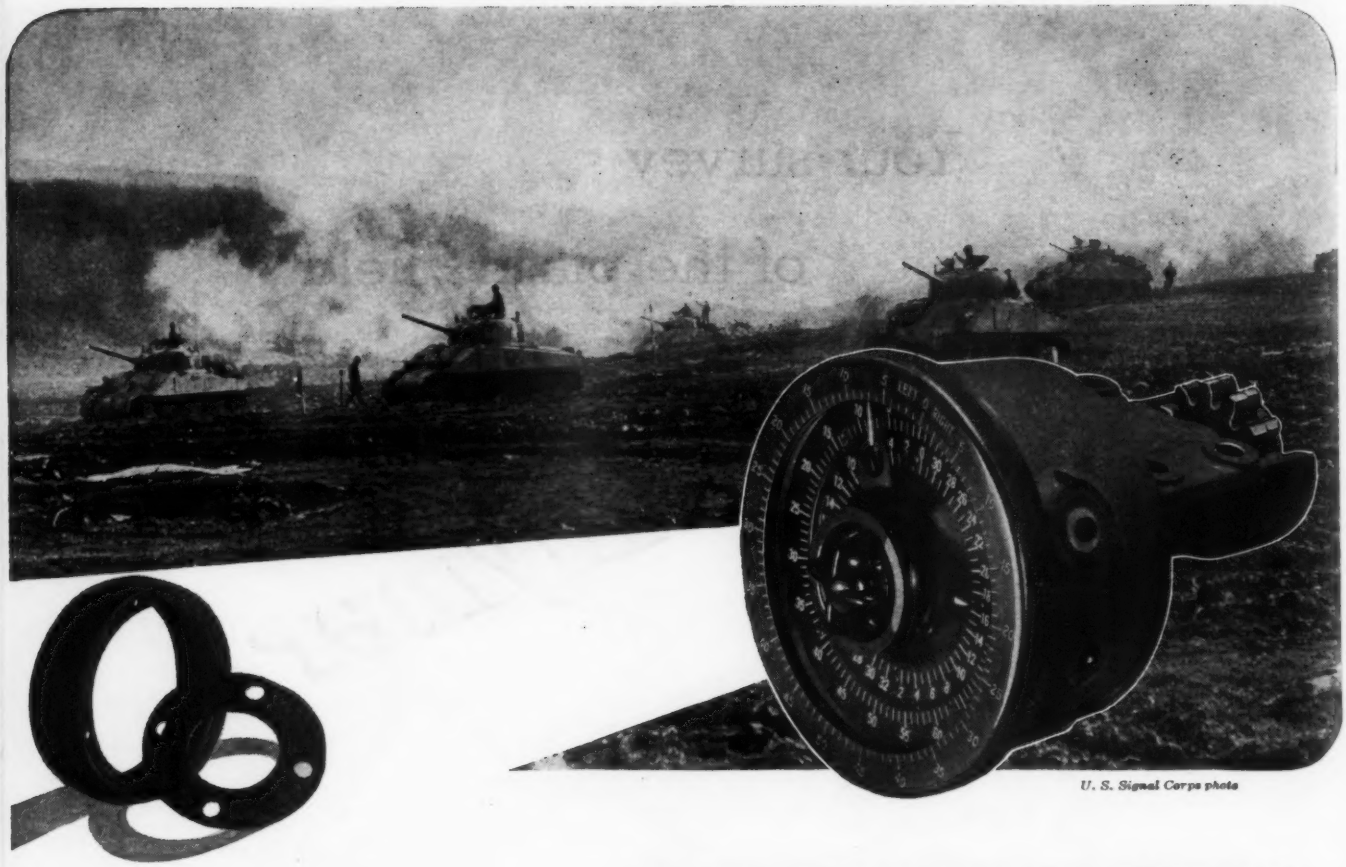

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The *azimuth indicator* (illustrated) is made by the Beam Manufacturing Company of Webster City, Iowa. The rubber parts (illustrated) are produced for "Beam" by The Ohio Rubber Company. Like all components of the *azimuth indicator*, these rubber parts must conform to rigid standards.

From beginning of manufacture to "end use" of the *azimuth indicator*, the aim is ACCURACY. When *YOUR* aim is accuracy in mechanical molded and extruded rubber or synthetic rubber parts—call for—

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We start with alloys that have a certain amount of natural ability to endure very high or very low temperatures, or alloys that have any other combination of properties called for by the job.

And then these properties are enhanced by heat treating, which has developed into a very exact science.

Research has given the steel founder a lot to work with. Tell him what conditions you want to meet, and he can provide steel castings with prescribed-in-advance mechanical properties.

If you let your steel foundry work with you at the planning level, you can be sure of results—sure of satisfactory performance in the finished product.

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MODERNIZE AND IMPROVE YOUR PRODUCT WITH

STEEL CASTINGS

Where clean air is an essential "material"... specify Dust-Stops*

In many types of equipment *clean* air is an *essential material* for the protection of precision parts, for the attainment of maximum efficiency, for the elimination of excessive maintenance and for the facilitation of operation under adverse conditions.

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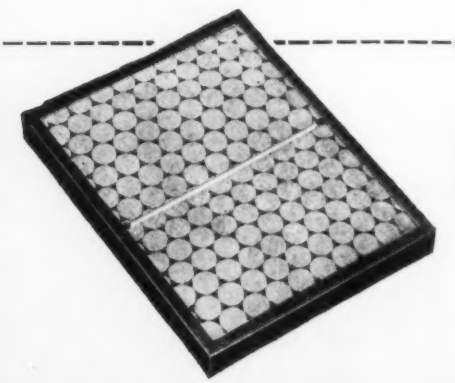
Because of their low cost and ready availability from suppliers in nearly every community, Dust-Stops that have done their job can be easily and economically replaced.

Why not give your products the competitive and operating advantages of Dust-Stop Air Filters? *Write for complete information today: Owens-Corning Fiberglas Corporation, 1913 Nicholas Building, Toledo 1, Ohio. In Canada, Fiberglas Canada Ltd., Oshawa, Ontario.*



DUSTOP AIR FILTERS

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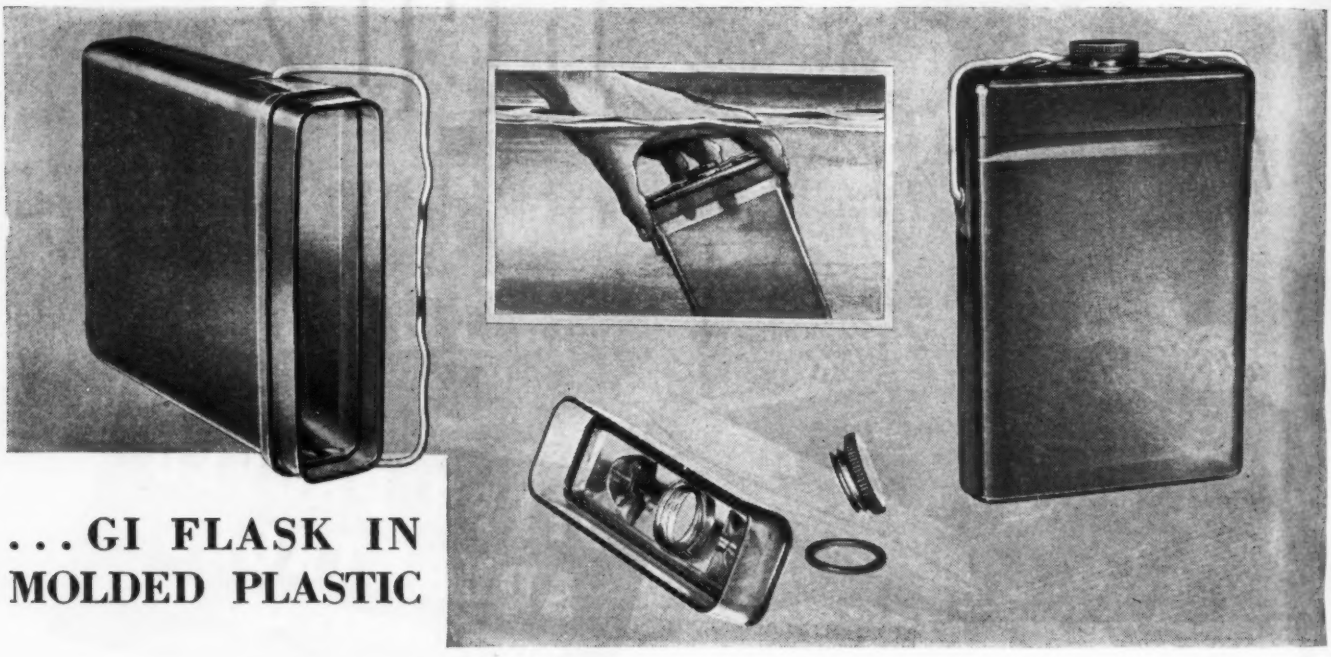

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Shows STANDARD Engineering for Versatility

On land and sea and in the air service, many a GI owes his very life to this emergency rations kit engineered by the Army Air Forces specialists at Wright Field.

For this particular job, *Standard Molding* designed the multi-purpose flask illustrated. It is suitable for use not only in the Arctic, but also in the Tropics, overcoming the hazards of temperature and humidity extremes, fungus growth, corrosion, shock and moisture.

This multi-purpose flask is an example of the versatility of molded plastic when custom-designed by *Standard Molding* of Dayton. Your product's plastic design can also be coordinated with its ultimate service conditions. *Standard's* Production Design Service is as near as your telephone. Call Dayton or call or write our nearest branch office, listed immediately below.

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EASTERN STAINLESS
SHEETS
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Technical Service
The EASTERN STAINLESS technical staff is readily available to analyze existing or contemplated applications of stainless steel sheets. Its many years of experience in this special field and modern research and development facilities serve two major purposes. First, to aid in the development, establishment and scientific control of modern production methods. Second, to form a link between our production units and the consuming industries. This service relates to all phases of the production, processing and fabrication of stainless steels and thus is of special value to producer and consumer alike. Consult with our technical staff in fabricating matters, performance problems or new developments. EASTERN STAINLESS Technical Service will gladly respond with up-to-date information and advice.

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Design that part in ArmaSteel*

The metal that boosts output, cuts costs, saves time, when "GO-Day" comes

IN THE AUTOMOTIVE AND DIESEL INDUSTRIES

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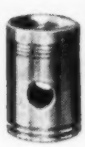

A leading Diesel manufacturer has used ArmaSteel pistons for years, chalking up impressive records of continuous service.

GEARS

Faster gear production through casting closer to finished dimensions and easier machining is a leading advantage of ArmaSteel.

CLUTCH THROWOUT COLLARS

The special qualities of ArmaSteel well fit it for the heavy loads and wear to which throwout collars are subjected.

The time lag from plan board to finished product can be cut sharply with ArmaSteel, the metal that has proved its mettle in hundreds of strategic war uses. In your reconversion plans consider these factors:

1. ArmaSteel is cast to conform closely to final shapes, cutting machining time, lowering cost of manufacture and reducing scrap loss.
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3. ArmaSteel has a uniform structure and a high yield ratio, with good fatigue and wear properties.
4. ArmaSteel responds to selective hardening by any of the commercial processes, such as induction, flame-hardening or bath immersion.
5. ArmaSteel maintains its properties at sub-zero temperatures.
6. ArmaSteel may be machined and polished to the mirror finishes so necessary to reduce friction.
7. ArmaSteel can be cast to combine several parts in one integral casting, thereby reducing machining and assembly costs.
8. ArmaSteel can be heat-treated to cover a wide range of physical properties.

Leading manufacturers have proved ArmaSteel to be an exceptionally versatile material, adaptable to varied requirements and lending itself to time-saving techniques.

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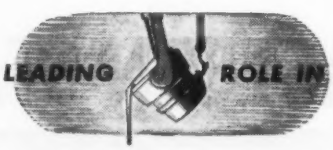

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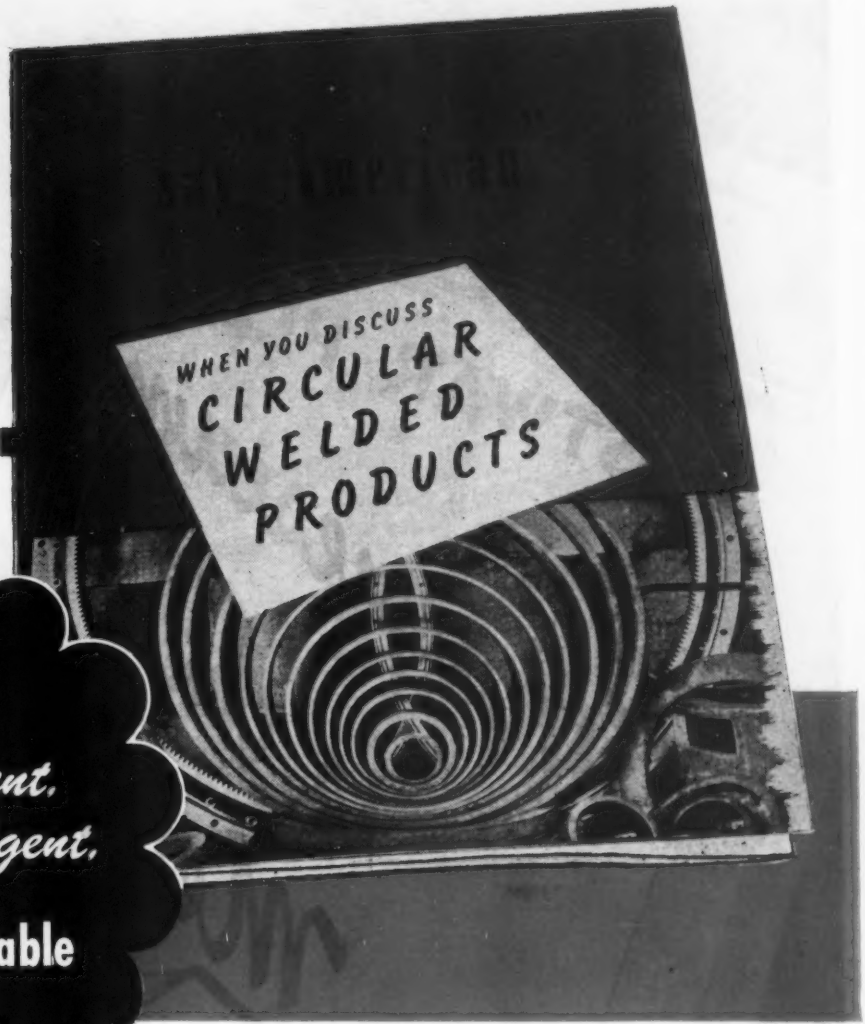

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● It describes the advantages and substantial savings offered by the welding process. It shows a wide range of ring assemblies and the adaptability of fabricating by welding that heretofore was not considered or thought possible. It includes a table showing the wide range and sizes of standard rings and bands.

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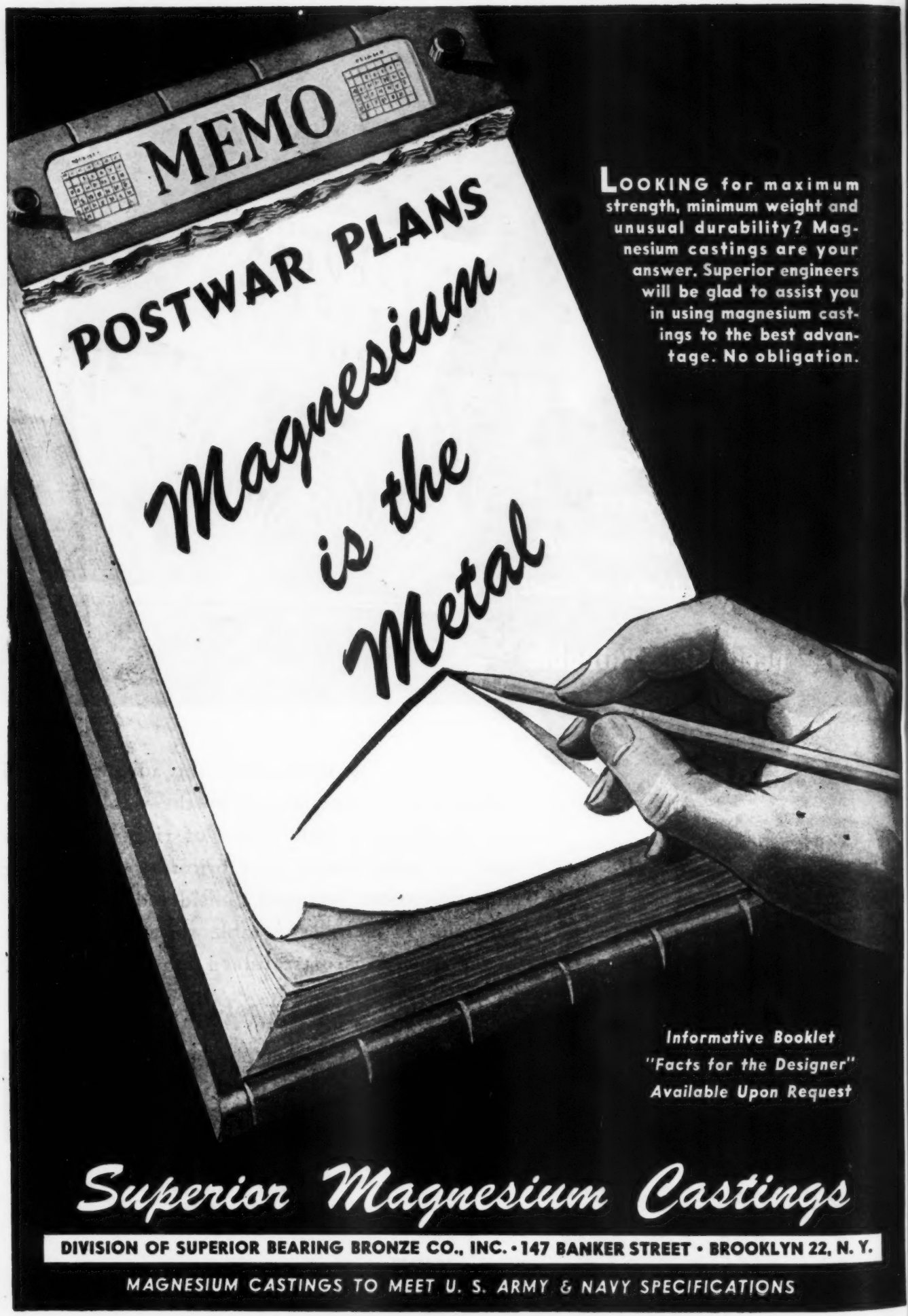

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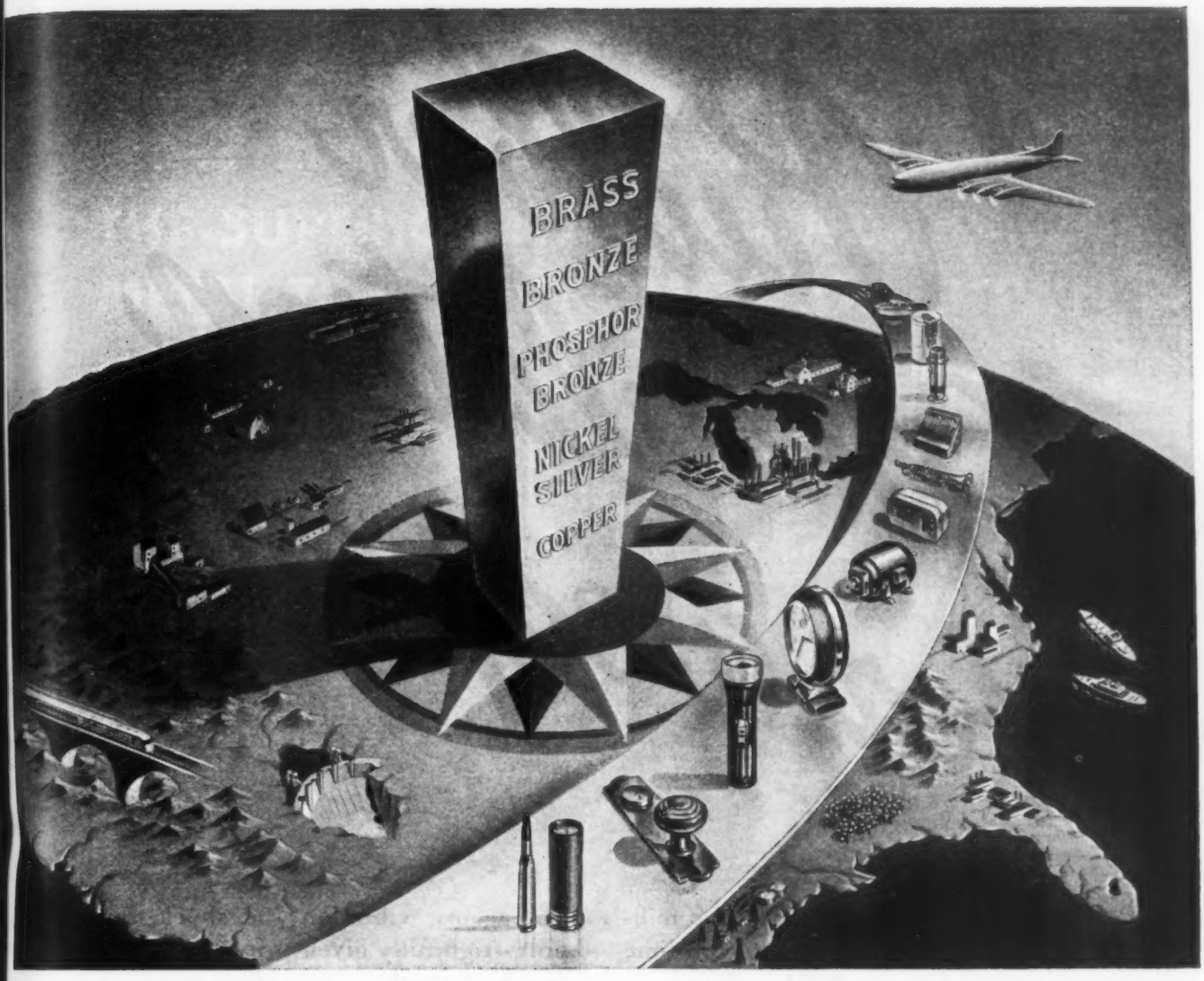

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WELDRAWN Stainless meets U. S. Government Specification AN-T-43—a typical example of the standard of performance which you may expect when you specify Superior **WELDRAWN** for a wide variety of small tubing applications.

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FOR EVERY SMALL TUBING APPLICATION FROM 5/8" OD DOWN

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SEAMLESS and Patented LOCKSEAM Cathode Sleeves

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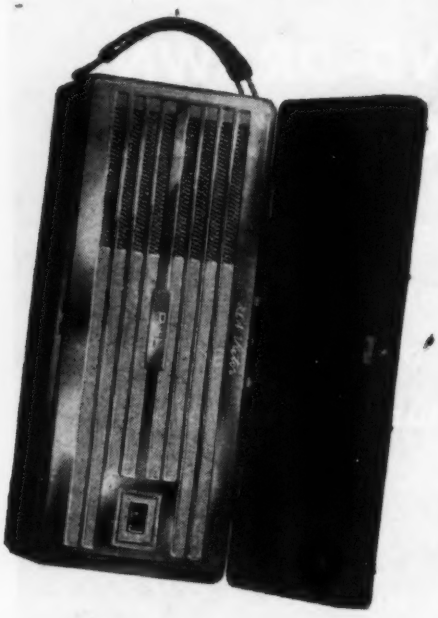
Economical production



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The R. C. A. portable radio was a GRAMMES Contract Service prewar achievement in product development and improvement plus lower manufacturing and assembling costs. Its smart, eye-appealing beauty of design and remarkable quality performance were sales-making features that *sold!* We are working with R. C. A. on their postwar program.

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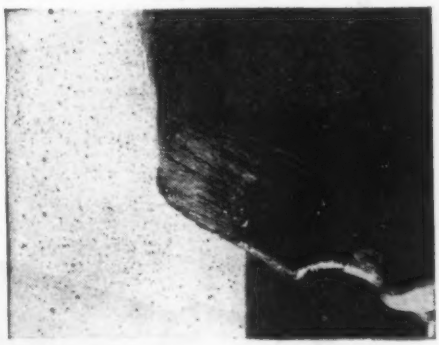
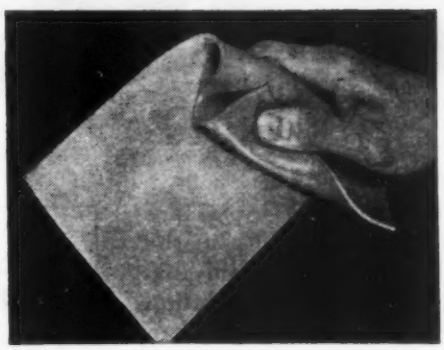
TYGON--*the corrosion-resistant Paint*

CHEMICALLY INERT • FLEXIBLE • TOUGH • NON-AGING





OF TOP importance in any chemical plant maintenance program are the steps taken to prevent corrosive deterioration of plant equipment and buildings.

Various corrosion-resistant materials are available, which when properly engineered will protect tanks, pumps, pipe, valves and other equipment from the corrosive attack of the specific chemicals they are designed to handle.

But the corrosive problems created by an atmosphere heavily loaded with mixed fumes, gases and moisture, and by condensation, frequently prove troublesome, costly and difficult of solution.

To solve this problem of protection against corrosive atmosphere, U. S. Stoneware engineers developed Tygon Paint. Tygon Paint is a liquid formulation of pure Tygon—the flexible, rubber-like material used to line acid tanks. Specially prepared Tygon sheets are liquefied by the addition of appropriate solvents. This liquid Tygon is then applied over properly prepared and primed surfaces just like an ordinary paint. The solvents quickly evaporate, leaving a tough, sturdy, durable, protective film of pure Tygon. This tough, non-aging, non-flammable, and non-toxic Tygon film provides lasting protection against almost all corrosive fumes. Not only are Tygon Paint films resistant to the attack of most acids and alkalis, but they are likewise unaffected by oil, gasoline, alcohols, fresh or salt water.

Tygon Paint films do not become excessively brittle at low temperatures nor soften at temperatures up to as high as 175°F. With special primers such as Tygon TP-109, temperatures as high as 200°F may be handled satisfactorily.

Unlike ordinary paints, Tygon will not oxidize and chemically deteriorate with age. Tygon Paint films will not craze, crack, check, chip or weather. Tygon Paint is easy to apply by spray gun or brush to almost any surface —metal, concrete, stone, wood. It air dries quickly, usually within an hour. The number of coats required depends on the anticipated severity of the attack.

Engineers like it, not only from a surface protection point of view, but from an appearance standpoint as well. Tygon Paints are available in a wide color range including white, black, gray, green, red, blue, aluminum and clear. The smooth surface does not wet readily, resists the accumulation of greasy fume scum, washes easily clean.

Would you like to try it? We'll be glad to send you, without charge, an ample sample for any tests you might care to make. Address your requests for samples to: Process Equipment Division, The U. S. Stoneware Company, Akron 9, Ohio.

Other Tygon formulations of interest to the chemical engineer:

TYGON SHEET STOCKS: For heavy duty tank service where corrosive and abrasive conditions are severe, use Tygon-lined steel tanks. A full 3/32" of sturdy Tygon sheet is applied to the steel shell by our exclusive process to form a continuous one-piece tank lining—effective and durable protection.

TYGON FLEXIBLE TUBING: Translucent or opaque, in diameters up to 1¼" O.D. and in varying wall thicknesses, for fluid or gas transmission. Has a flex life ten to twelve times that of rubber.

Complete descriptive details are available in Bulletin 1636, free, on request.

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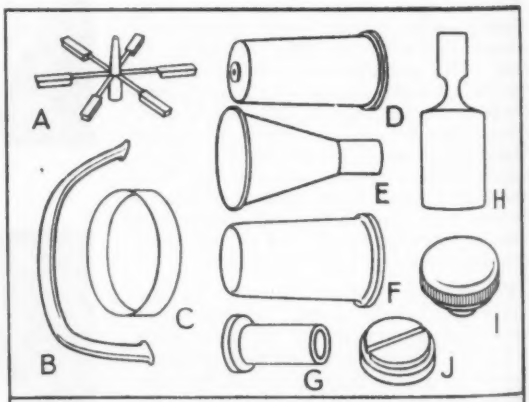
So count on Continental to suggest the exact plastic features your product should have. You'll find an alert, progressive organization ready to give sound, practical advice and assistance at all times.

Tune in "REPORT TO THE NATION," every Saturday over CBS coast-to-coast network



(a) Drawer pulls—injection; (b) Air scoop mounting—compression; (c) Globe base—injection; (d) Sales ticket-holder—compression; (e) Funnel—compression; (f) Shell for vaporizer—compression; (g) Bushing—compression; (h) Hairbrush handle—injection; (i) Gearshift ball—compression; (j) Brush cap for motor—compression.

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• • • COLD WORKING of sheet steel into deep drawn shapes is a tricky job and requires experience. The amount of draw must be considered, die design, metal flow, grain structure, to mention only a few. Here at Transue's we have the equipment and the personnel with wide knowledge and long experience. T & W customers trust us with their difficult deep drawn stampings.

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stainless strip steel

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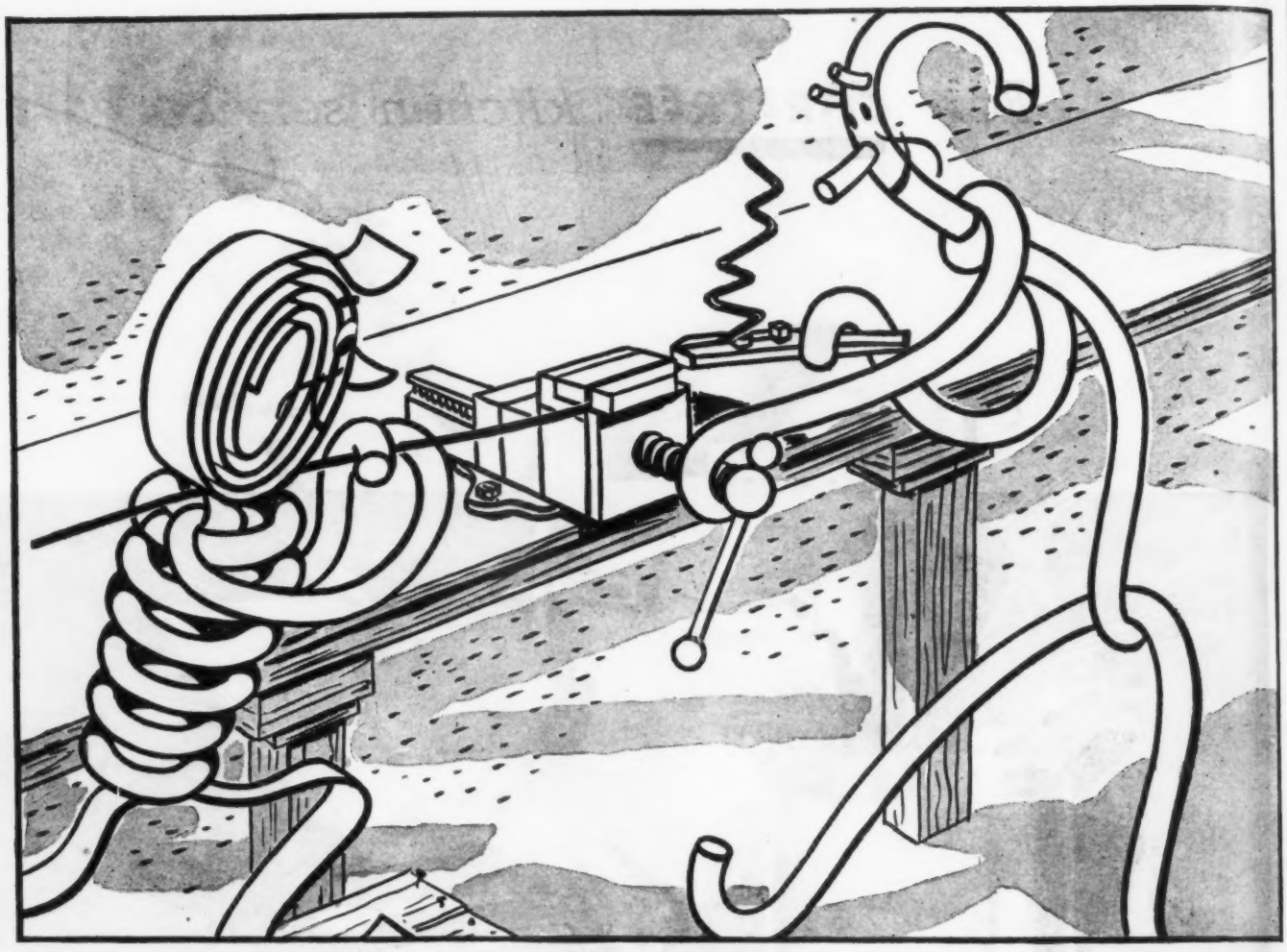
All the stainless virtues of finer appearance, ease of cleanliness, high strength and corrosion resistance are found in Superior Stainless Strip Steel . . . made precisely to your specifications of composition, temper, width and thickness, in *long coils* for high production of stainless kitchen ware.

☆ ☆ ☆ ☆ **Superior Steel** ☆ ☆



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Let us send you this Free Book

Our book "Springs and Wire Forms" contains valuable technical information, formulae and tables relating to spring performance. For your FREE COPY write Spring Division, Wickwire Spencer Steel Co., New Bond St., Worcester 6, Mass.

Wick and Spen are great believers in tests. They make their own steel—and test it. They draw their own wire—and test it. And before *and after* it's made into springs—it's tested.

One of these tests—the bend test—is shown above. A piece is cut from each end of a coil of spring wire. It's placed on a bending jig and bent in planes around its own diameter. If it fractures the entire coil is rejected.

Our spring and formed wire specialists, many of whom have been with us for over 25 years, have engineered well over 50,000 different spring designs.

If you are planning a post-war product calling for springs or wire forms it will pay you to consult our engineers. They have saved time, trouble and expense for many manufacturers who have taken us into their confidence *before* the final design stage of their product. Write Spring Division, Wickwire Spencer Steel Company, New Bond St., Worcester 6, Mass.

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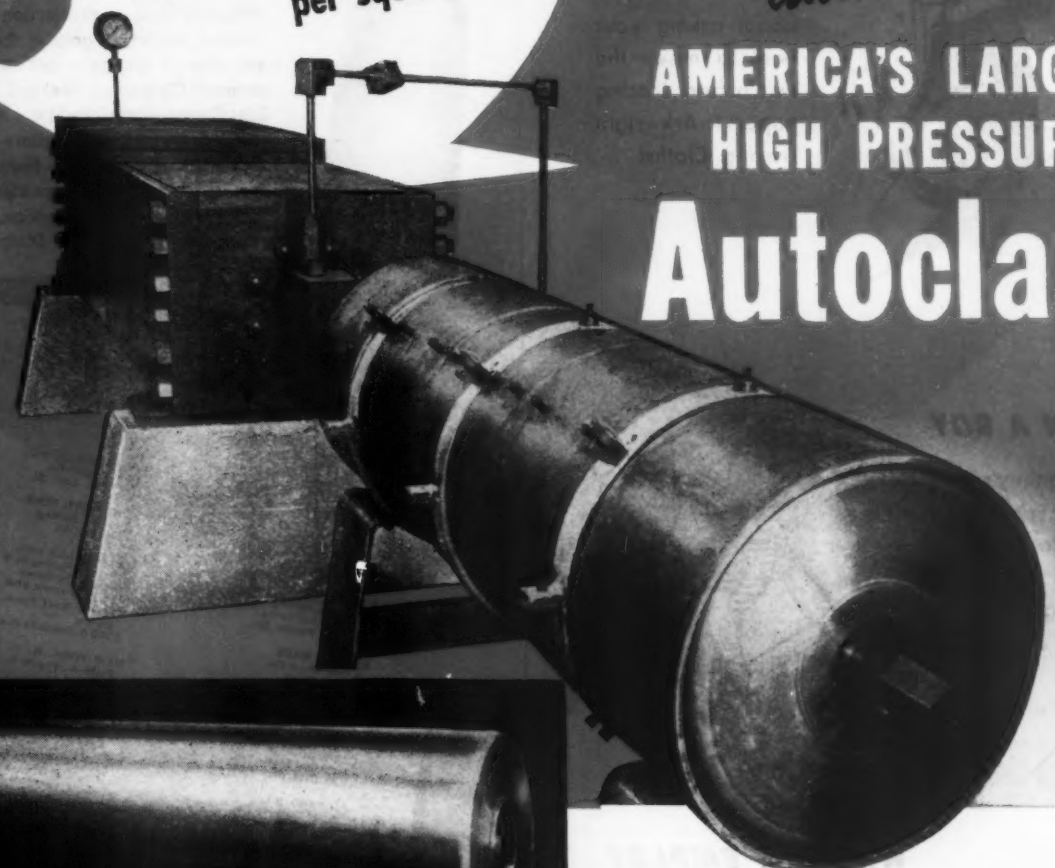
Specifications
50,000 pounds working pressure per square inch
Tested to
70,000 pounds per square inch

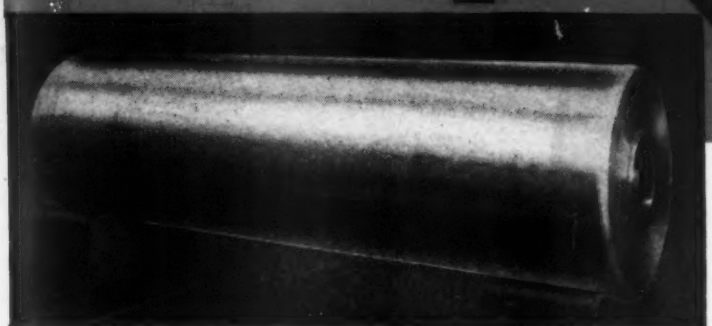
struthers wells

Designs and Builds

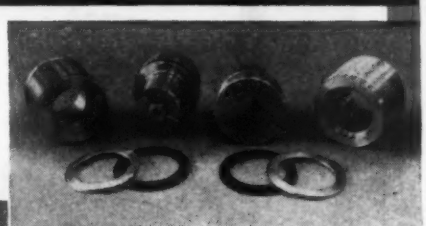
AMERICA'S LARGEST HIGH PRESSURE

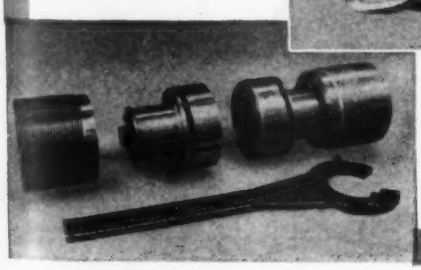
Autoclave





Above: The 50,000 pound High Pressure Autoclave with the protective jacket removed.





Below: These two photographs show the intricate design for the closures.

Here is a typical example of the engineering "ingenuity" available at Struthers Wells:

"For years Struthers Wells have built laboratory Autoclaves suitable for working pressures up to 25,000 pounds per square inch, BUT, a production unit suitable for 50,000 pounds working pressure per square inch had never been built! However, this unit was vitally needed—*in a hurry*. The Struthers Wells engineering department burned midnight oil for many nights—the plans finally came off the drawing board—proper materials selected—forged and machined—in less than two months the machine was ready for testing—not at 50,000 pounds—BUT *70,000* pounds. The completed unit is now installed and working 24 hours a day in a very highly satisfactory manner, according to our customer."

This same advanced engineering and manufacturing facility is available to you, too!

Informative Autoclave Bulletin on request

ARMY NAVY SW

STRUTHERS WELLS CORPORATION
SPECIAL EQUIPMENT DIVISION
TITUSVILLE, PENNA.
PLANTS AT TITUSVILLE AND WARREN, PA.
Offices in Principal Cities

DON'T BE COY

about asking your boss to make the switch from tracing papers to Arkwright Tracing Cloths!

EVEN A BOY

can see they're better for draftsmen. Better in every way — even in cost, in the long run!

WHY NOT EMPLOY

the next two minutes most profitably by writing for free samples? We'll send them gladly. Write, Arkwright Finishing Company, Providence, R. I.

Sold by leading drawing material dealers everywhere

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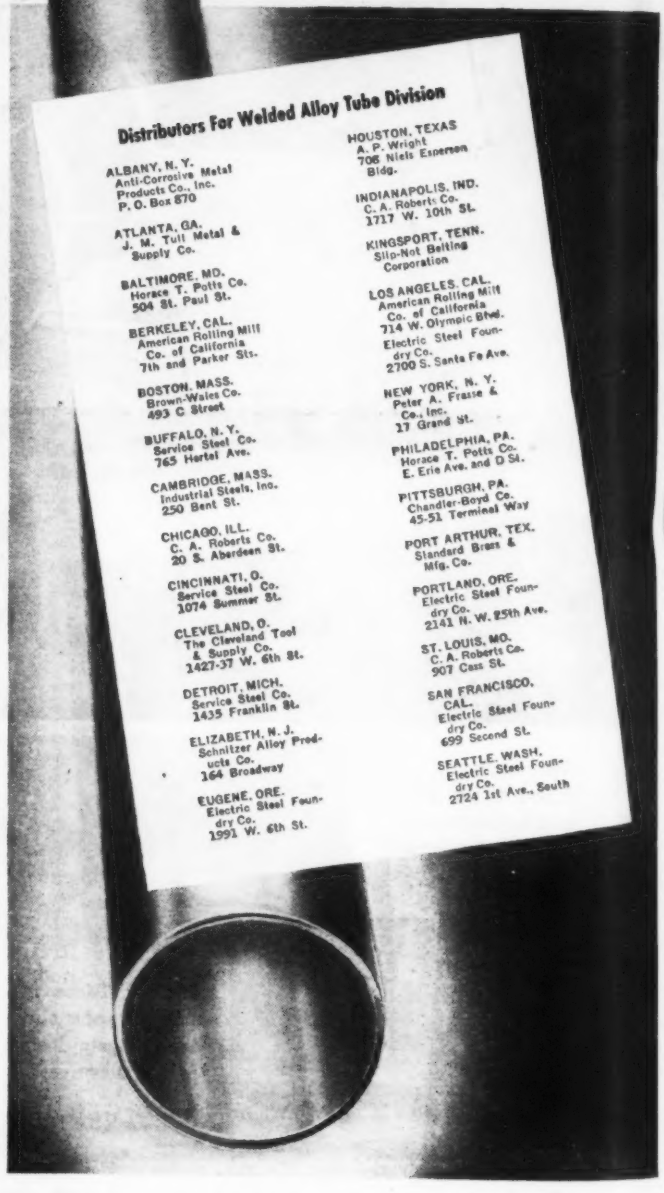
TRACING CLOTHS

AMERICA'S STANDARD FOR OVER 20 YEARS

Stainless Tubing Available from These Distributors

Whether it is a production emergency or a routine matter of getting the required analysis, size or gauge — get in touch with your nearest Carpenter Welded Stainless Tubing Distributor—listed below. Ample stocks are carried by all distributors backed by mill stocks to give you the fastest possible service. Call on your Carpenter Distributor also for help in the selection, application or fabrication of Welded Stainless Tubing.



THE CARPENTER STEEL COMPANY

Welded Alloy Tube Division • Kenilworth, N. J.

STAND A SHOCK?

CARBON AND GRAPHITE can be heated to incandescence and plunged into cold water without the slightest harmful effect!

This extraordinary resistance to thermal shock is the basis of many applications of "National" carbon and graphite and of "Karbate" products* in the metals, chemical, electronics, textile and other industries.

But these materials also have other equally important qualities. So you must think of them in terms of *all* their properties . . . in combinations possessed by no other materials.

It will help you to understand why carbon run-out troughs give up to six months' service in steel mills . . . why graphite anodes made the mercury-arc rectifier practical . . . why graphite molds for ferrous and nonferrous metals don't crack, spall or stick . . . why graphite bubble caps retain their original dimensions throughout the heat cycle of any chemical tower . . . and why "Karbate" heat exchangers resist practically all acids, alkalies and solvents.

Our nearest Division Office will gladly furnish full details.

*Impervious carbon or graphite.

The words "National" and "Karbate" are registered trade-marks of National Carbon Company, Inc.

BAR OF WHAT?
Carbon, Graphite, or "Karbate" materials, of course!

NATIONAL CARBON COMPANY, INC.
Unit of Union Carbide and Carbon Corporation
UCC
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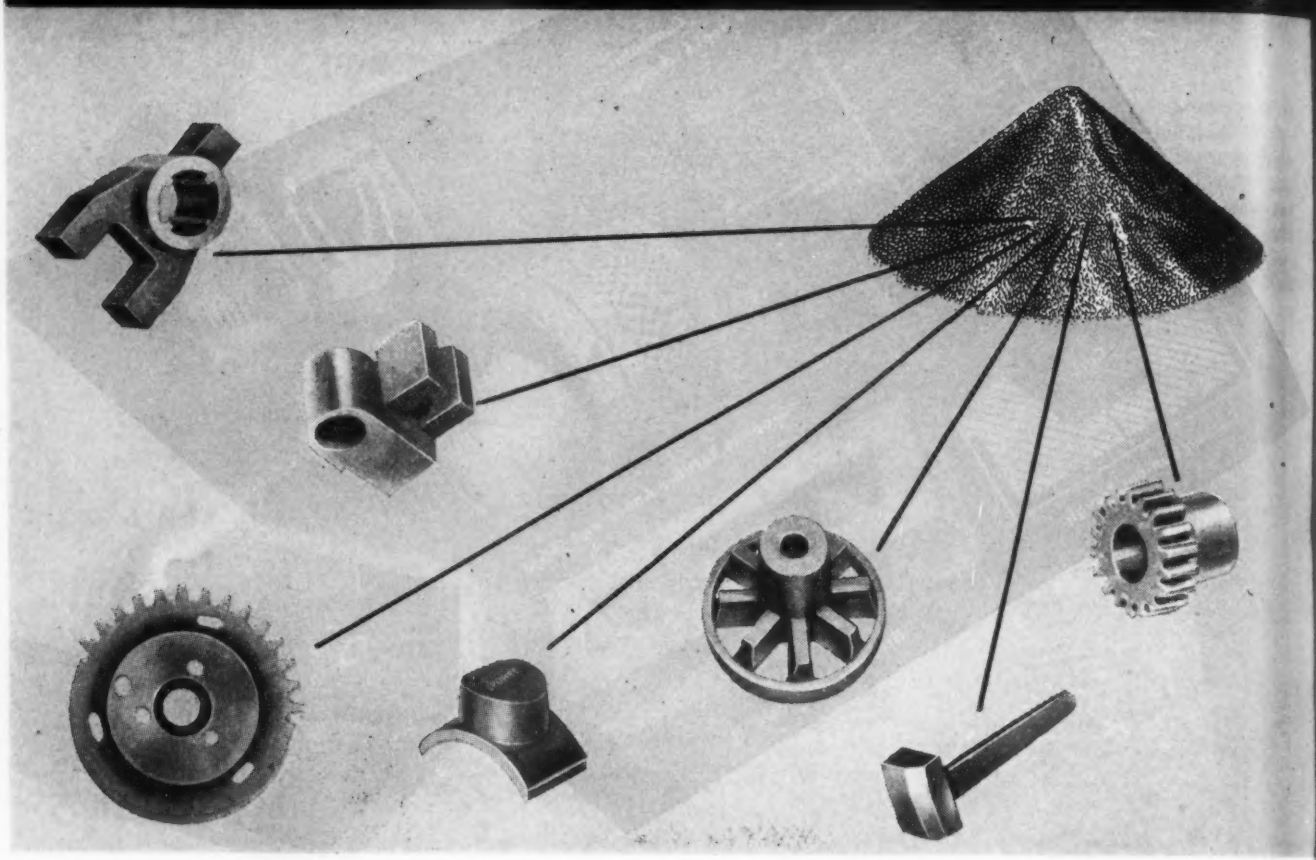
Division Sales Offices: Atlanta, Chicago, Dallas, Kansas City, New York, Pittsburgh, San Francisco

KEEP YOUR EYE ON THE INFANTRY . . . THE DOUGHBOY DOES IT!

POMET POWDER METALLURGY



. . . powder to parts in three steps

Think what Pomet Powder Metallurgy can mean to a manufacturer rushing to get peace-time products on the market!

He can get many types of small parts quicker and cheaper.

He can have volume with quality—close tolerances, density, ductility—and many other desirable characteristics *to order.*

And he can be sure of the same type of precision manufacturing that is now meeting rigid Army and Navy specifications.

By doing many intricate and accurate jobs quicker, Pomet Powder Metallurgy has earned the right to be called one of the big bottleneck busters of this war. Parts are made with little or no machining in three operations: 1. They are compacted from powder in a single stroke on powerful presses. 2. They are sintered in ovens at controlled temperatures. 3. Lastly they are coined to increase dimensional accuracy.

If you are interested in the quantity production of small parts of bronze, brass, iron, steel and other metals or special alloys, it will pay you to learn more about Pomet Powder Metallurgy. Write for complete information.

CLOSE TOLERANCES
WITHOUT MACHINING

HIGH DENSITY

POMET

DUCTILITY OR HARDNESS
COMBINED MATERIALS
WEAR RESISTANCE

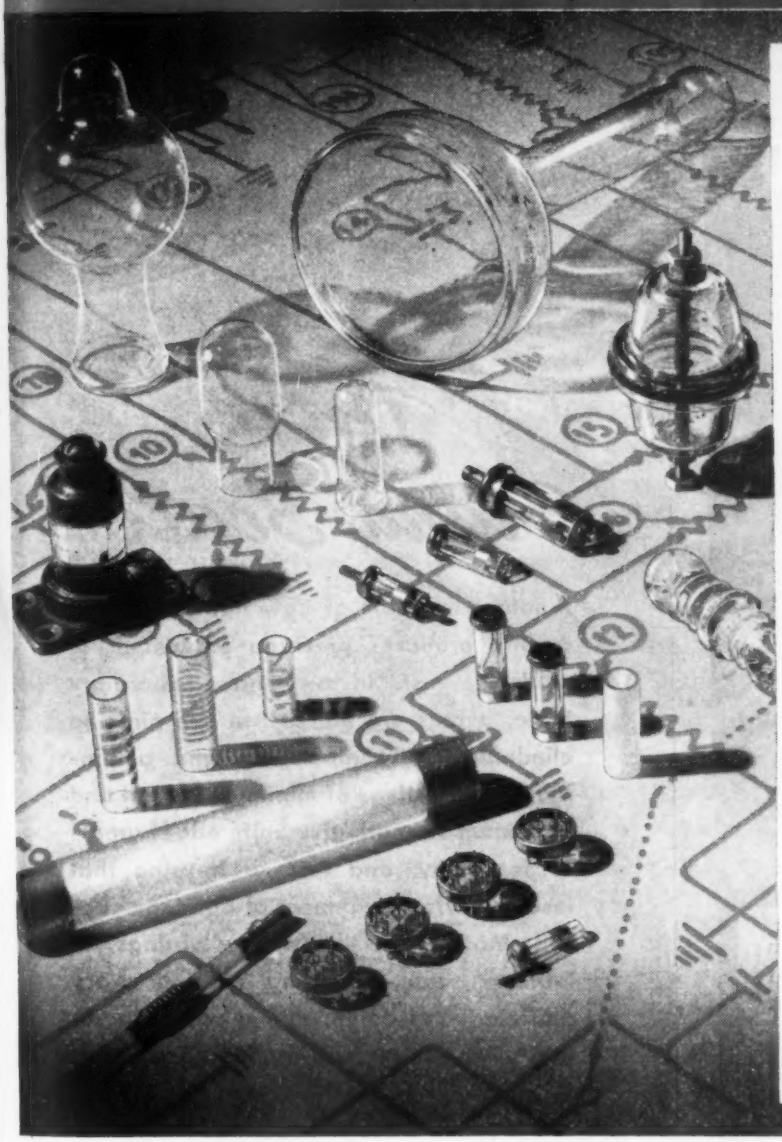
POWDER METALLURGY CORPORATION

A SUBSIDIARY OF GENERAL BRONZE CORPORATION

30-44 Greenpoint Avenue **Long Island City 1, N.Y.**

WHAT WILL YOU NEED TO PRODUCE BETTER POST-WAR PRODUCTS?

CORNING GLASS GIVES YOU



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Metallizing
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High dielectric strength — high resistivity—low power factor—wide range of dielectric constants—low losses at all frequencies.

Permanent hermetic seals against gas, oil and water readily made between glass and metal or glass and glass.

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AS YOU plan post-war electronic products, give a thought to versatile glass. We really mean glasses, for Corning has, at its fingertips, 25,000 different glass formulae from which to select those especially suited to your electronic applications. Let us show what glass can do for you. We may already have a solution — or Corning Research can find the answer for you. Address Electronic Sales Dept., R-4, Bulb and Tubing Division. Corning Glass Works, Corning, New York.

CORNING *means* Research in Glass

Electronic Glassware

VYCOR — CORNING — PYREX

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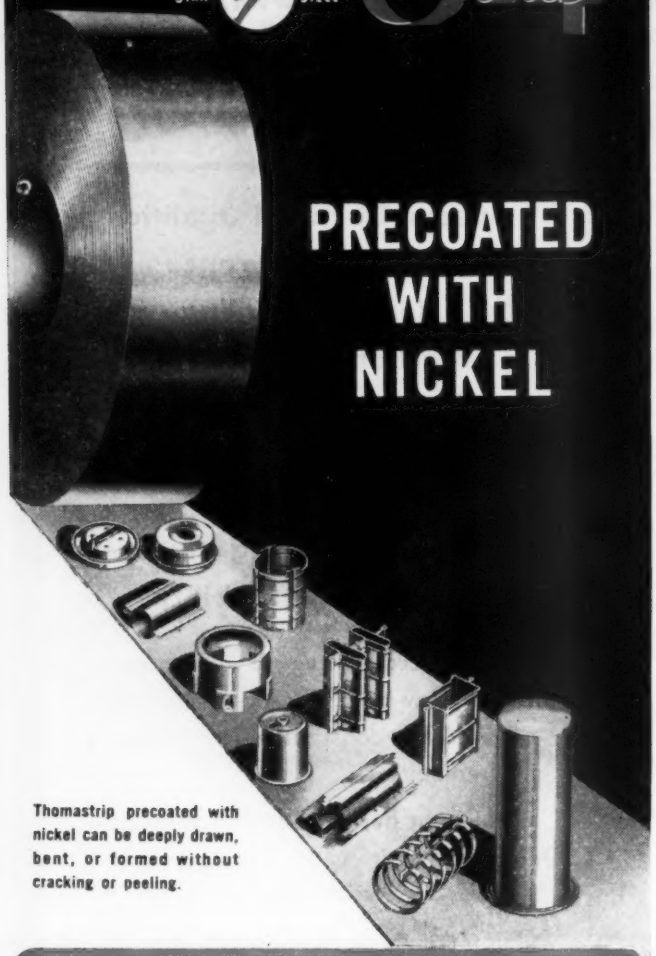
Thomas Strip

COLD ROLLED STRIP STEEL

PRECOATED WITH NICKEL



Thomastrip precoated with nickel can be deeply drawn, bent, or formed without cracking or peeling.

Precoated Thomastrip often gives production results that have never before been expected of steel. Nickel coated, for example, provides protection against rust and corrosion during fabricating of parts . . . protection against scaling during heat treating . . . a non-ferrous coating over a ferrous base metal . . . a ductile surface for deep drawing . . . and an ultimate finish. With nickel coated Thomastrip, you may be able to replace more costly metals without loss of production or quality. Your inquiries will be answered promptly.

ELECTRO COATED ZINC, COPPER, NICKEL AND BRASS . . . HOT DIPPED TIN AND SOLDER . . . LACQUER COATED IN COLORS . . . UNCOATED PRECISION STRIP, CARBON AND ALLOY SPECIALTIES.

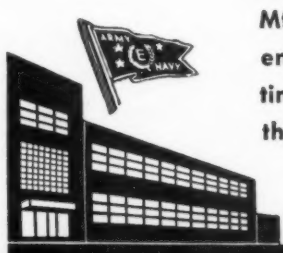
THE THOMAS STEEL CO., WARREN, O.

COLD ROLLED STRIP STEEL SPECIALISTS

On a Grand Scale!

Another example of how Mt. Vernon die casting produces precision equipment at moderate cost. In this Ohaus Laboratory Scale, beams are die cast in one piece to eliminate costly machining and assembling. Die castings of minimum weight and maximum strength give knife edges greater sensitivity, and form a housing that insures perfect alignment of bearings. Result: Mt. Vernon "know-how" brings an intricate scale, featuring high accuracy and clarity of detail, into a price bracket that even small laboratories can afford.

Perhaps it's time for you to weigh the many advantages of die casting. If so, Mt. Vernon's experienced engineers can be of inestimable help. Why not let them prove it?



MT. VERNON DIE CASTING CORP.

MT. VERNON, NEW YORK

In 1795

When *Washington* was president "Standard Steel"

forged the first link in a chain of service 150 years long

There were only 15 states then and the fourth congress was sitting, back midway in Washington's second term. But it's amazing the many things that happened which directly affect America's life today.

General Wayne concluded a treaty with twelve Indian tribes, obtaining 25,000 square miles of land that later became southeastern Indiana and southern Ohio. Connecticut sold the balance of the Western Reserve, which made up still more of what was to be the Buckeye State. A day of Thanksgiving was appointed by statute, and a new naturalization act was passed, requiring five years' residence, and the renunciation of all allegiance to foreign sovereigns, and all claim to titles of nobility. Then, too, the infant republic got another infant industry . . . *Freedom Forge.*

Today, a direct descendent of Freedom Forge—Baldwin's Burnham plant, still in the same location after 150 years—still serves America with castings and forgings that reflect a century and a half of continuous progress and pioneering. In every generation, "Standardize on Standard" has been a dependable short-cut to assured satisfaction. The Baldwin Locomotive Works, Standard Steel Works Division, Burnham, Pennsylvania, U. S. A. Offices: Philadelphia, New York, Chicago, Washington, Boston, Cleveland, St. Louis, San Francisco, Houston, Pittsburgh, Detroit.

BLW THE BALDWIN GROUP

BALDWIN

ARMY NAVY

STEEL FORGINGS & CASTINGS

WOOL FELT... Mechanical functions fulfilled by this non-structural engineering material

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2. Polishing
3. Sealing ✓
4. Wicking
5. Vibration Isolation
6. Sound Absorption & Thermal Insulation
7. Shock-absorbing
8. Cushioning
9. Padding
10. Packaging
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12. Frictional

Millions of ball bearings are protected from the ingress of dirt, grit and moisture, or the leakage of oil and grease lubricants by means of Felt seals. Felt pistons for grease guns and self-filling fountain pens, glass pipe gaskets weatherstripping, and drive shaft housing seals typify the variety of Felt sealing applications.

In aviation, Felt is used for bomb bay door gaskets and to seal transparent nose cones.

Felt seals, gaskets, and retainers are *cut to close order* tolerances. Our facilities for mass production assure prompt delivery. Laboratory control assures uniformity on re-orders.

American Felt Company product engineers are available to discuss the latest techniques in Felt sealing — or to advise on any other Felt application. Write for Data Sheet #11, "Annular Designing and Dimensioning."

American Felt Company
TRADE MARK

General Offices: GLENVILLE, CONN.

New York; Boston; Chicago; Detroit; Philadelphia; Cleveland; St. Louis; Los Angeles; Seattle; San Francisco; Dallas; Atlanta

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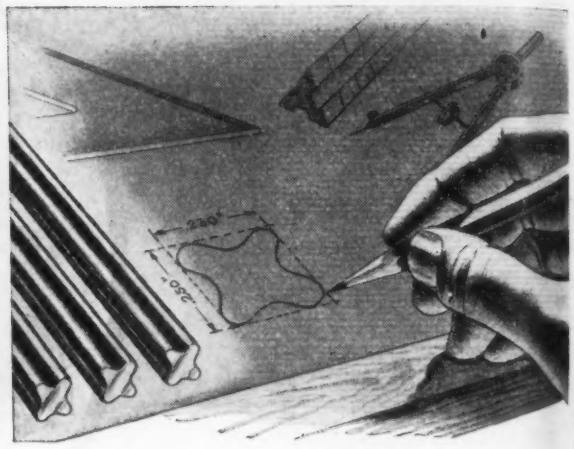
PAGE *Shaped* WIRE



YOU DRAW THE *SHAPE* . . . PAGE CAN DRAW THE *WIRE* . . .

PAGE is now drawing wire in many shapes — triangles, rectangles, octagons, hexagons, keystones, ovals, half-rounds, many other hard-to-describe special shapes. But, if you have use for shaped wire in the manufacture of your product, you are not limited to standard shapes. You draw the *shape*—**PAGE** can draw the *wire*.

• Yes, and **PAGE** will go further than that. From years of experience, **PAGE** has learned much about the economical application of shaped wire to manufacture. **PAGE** offers you the benefit of this experience in finding ways to cut your production costs through the use of shaped wire.

• For wire or information about wire—

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PAGE STEEL AND WIRE DIVISION
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Now You Can SEAL Spot Welded JOINTS

Against AIR, MOISTURE, and CORROSION

With Presstico

SPOT WELD SEALER

The problem of tightly sealing spot welded joints has been solved with the successful development of Presstico Spot Weld Sealer. Applied, *before* welding, to the faying surfaces of the metals to be joined, this sealer effectively prevents corrosion, assures an air and water-tight seal.

Tests prove that the sealer has no effect upon the strength of the weld, that it retains high cohesive, adhesive, and sealing properties throughout a wide range of temperatures. It eliminates the danger of rusting or corrosion in the joint between welds.

Application is simple and Presstico Spot Weld Sealer is available in three types — flow-gun, brush-on, and spray — each to meet a particular sealing problem or production process.

If you do spot weld sealing in your plant, it will pay you to get full information on Presstico Spot Weld Sealer. If you have *any* sealing problems, let Presstite work with you and your engineers — for Presstite Engineering Company has been specializing in the development of sealing compounds for industry for more than a quarter century. Write today.

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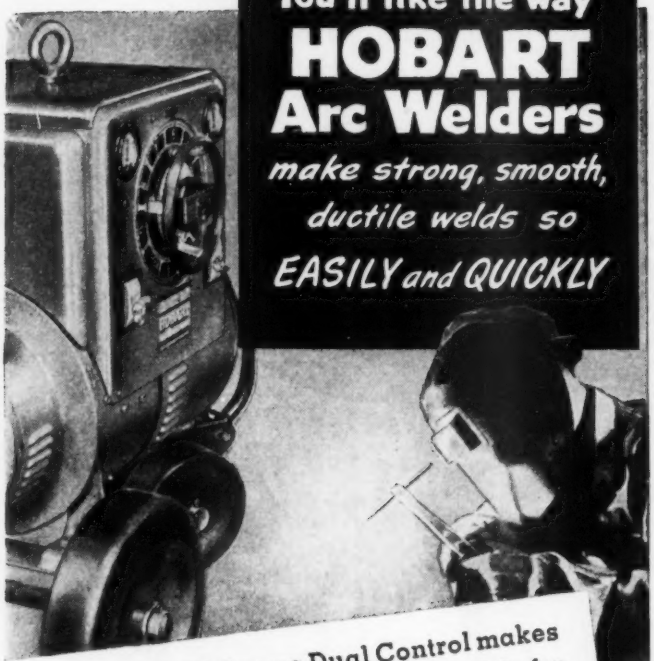
make strong, smooth, ductile welds so EASILY and QUICKLY



Hobart's Multi-Range Dual Control makes this fine, close control of the arc possible for all types of electrodes used in the most difficult welding positions. Just think, it's possible to obtain over 1,000 combinations of voltage and amperage . . . exactly the right amount of heat by simply turning the outer hand wheel to the desired range and then turning the inner wheel to the desired combination of voltage and amperage. An exclusive advantage you will find on no other make of welder. Try it on your job today!

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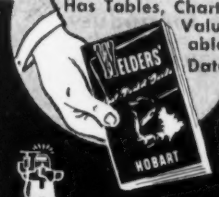

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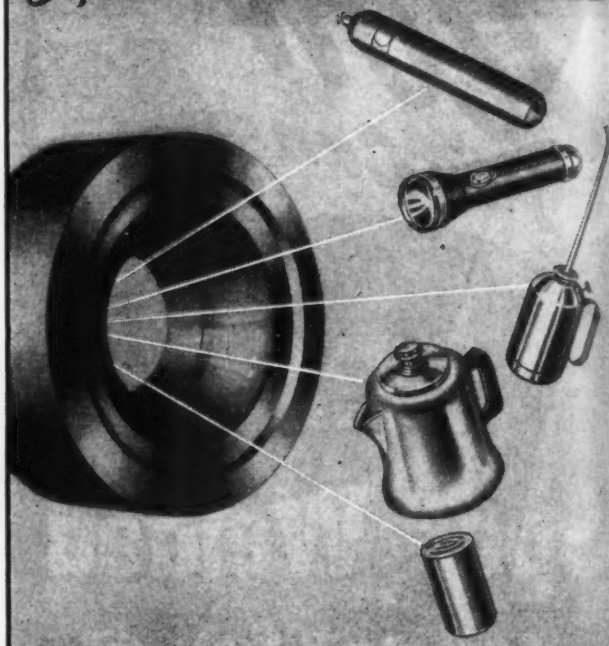
"One of the World's Largest Builders of Arc Welders."

DEEP DRAWN THROUGH . . . *Super-hard* TALIDE DIES



TALIDE DIES, with super-hard tungsten carbide nibs, are performing an outstanding War job today in producing millions of cartridge cases, bombs, rocket tubes, ammunition and other critically needed ordnance items.

The production advantages of LONGER DIE LIFE, MORE CONTINUOUS PRESS OPERATIONS, CLOSER TOLERANCE, BETTER FINISH and FEWER REJECTS are increasing the output of press lines all over the nation.

Tomorrow . . . these advantages plus the extra hardness, density and toughness of Talide Dies will make it possible to mass produce at lower cost deep-drawn automotive parts, kitchen utensils, flashlight cases, cosmetic containers, food and beverage cans, high pressure gas tanks and a multitude of other peace-time products.

Talide Sheet-Metal Dies, made by our exclusive Hot Press Method, are available in hole sizes up to 24". Our experienced organization is at your disposal.

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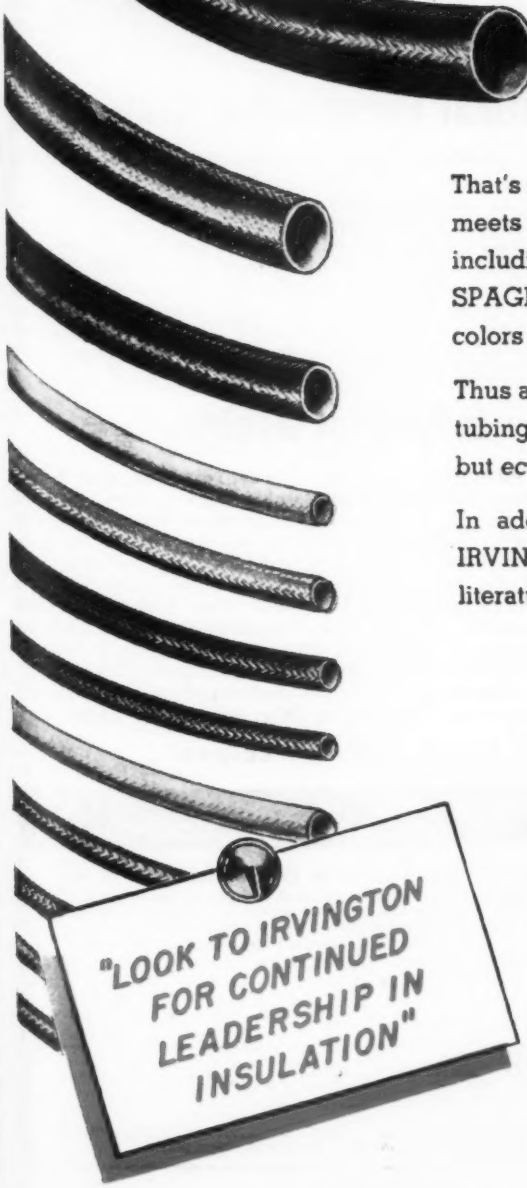
TUNGSTEN CARBIDE TOOLS · DIES · WEAR PARTS

ARE YOU USING THE TUBING *best* SUITED FOR YOUR JOB?

Irvington *can Supply it*



BEST suited means a varnished tubing or sleeving that meets *every* service requirement . . . at *lowest cost!*

That's the way IRVINGTON . . . long the leader in electrical insulation . . . meets *every* tubing or sleeving need. For IRVINGTON makes *all* the types including non-fraying FIBERGLAS . . . high voltage IRV-O-VOLT . . . RADIO SPAGHETTI and SATURATED SLEEVINGS . . . in a complete range of colors and A. S. T. M. sizes.

Thus a recommendation from IRVINGTON can be unbiased . . . you get the tubing *best* suited to your needs. not only from the standpoint of efficiency, but *economy* as well.

In addition, you get that extra increment of electrical surety which IRVINGTON'S 'know how' and 'manufacturing control' provides. For literature, or engineering assistance, write to Dept. 48.

IRVINGTON PRODUCTS:

- Cotton, Fiberglas, or Rayon Tubings and Sleevings — Varnished, Lacquered, or Vinylite Processed
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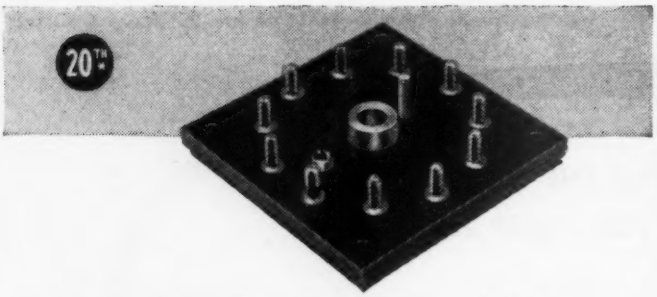
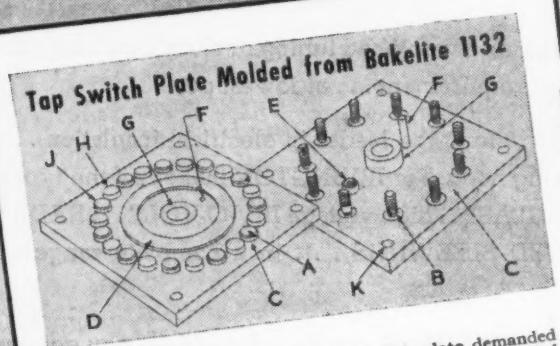


Tap Switch Plate Makes "GOOD CONNECTIONS"

HERE'S an electrical part that has made "good connections"... with plastics... and with Aico.

This tap switch plate... used in X-ray equipment... is molded from plastics for extreme accuracy and dimensional stability over a long period of service. It contains 14 molded-in brass and steel inserts for providing electrical contacts and for assembly with other parts. This is another difficult molding job, successfully engineered by Aico's plastic experts.

At Aico, high skills and experience gained in 29 years of precision molding are "on tap" for the solution to all types of plastics problems.



BAKELITE 1132 TAP SWITCH PLATE

MOLD DESIGN
Exacting requirements for this tap switch plate demanded expert mold making. Dimensions from base (A) of threaded terminals (B) to flat surface of plate (C) must be extremely accurate. Circular brass insert (D) is partially imbedded in molded plate; tapped part (E) of insert extends through molded part. Steel inserts (F) and (G) are flush with contact side of plate (C). Bosses (H), alternating with metal contact buttons (J), are plastic. Holes (K) are for assembly.

MOLDING METHOD
The transfer method, used in molding this part, offers a paramount advantage in its suitability for molding parts with numerous inserts. The inserts can be held in place more accurately than in compression molding because the mold is closed when material enters. Minimum flash is produced by this method, thereby cutting finishing time on parts which require removal of all flash from inserts.

MOLDING MATERIAL
The molded plate must be perfectly flat because of electrical contacts. Proper wall thickness had to be determined to provide the fastest possible cure and, at the same time, provide sufficient anchorage for inserts. Bakelite 1132 provided the chemical and physical properties required. This material has good dimensional stability, is suitable for molding inserts and has a good surface finish.

**This is No. 20 in Aico's plastics applications series. Send a request on your letterhead for file cards Nos. 1 to 20.*

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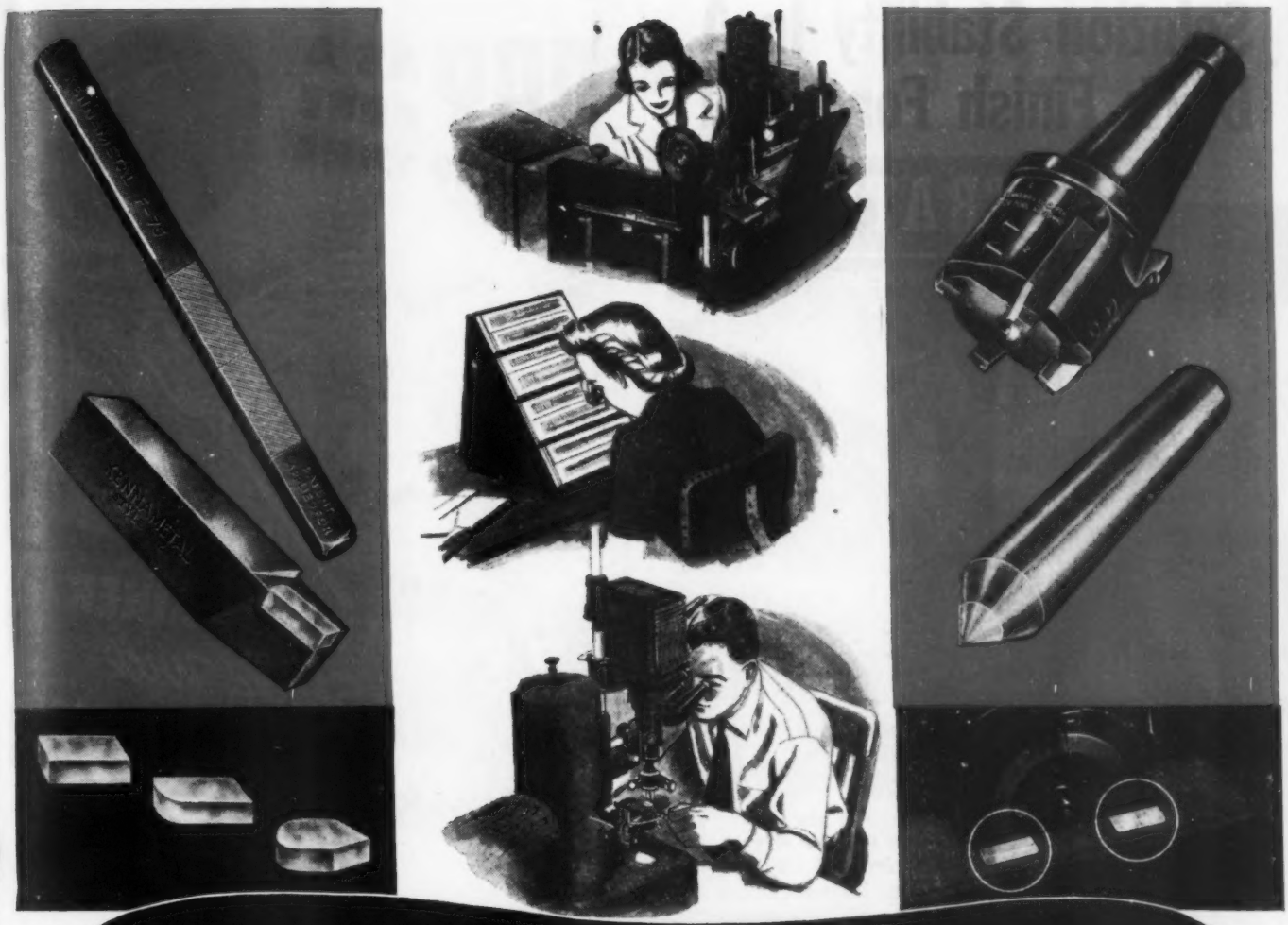


RESEARCH - Basic Reason for Better Carbides

Years of unrelenting research by Philip M. McKenna resulted, in 1937, in the discovery of the hardest man-made material—a unique intermetallic compound, tungsten-titanium-carbide, corresponding to the chemical formula $WTiC_2$. This compound is the basic ingredient of steel-cutting compositions of Kennametal. It distinguishes them from all other cemented carbides.

Introduced in 1938, Kennametal quickly became established as the tool material that made possible machining of hard steel, accurately, at greatly increased speeds. Kennametal's spectacular performance in this field was a tremendous stimulus to increased research activities, which since 1938, have led to the successful development of:

- *a series of Kennametal compositions, of varying degrees of hardness, strength, and toughness, exactly suited for machining various types of steel, as well as tough, stringy nonferrous alloys.*
- *a new, highly abrasion-resistant tungsten carbide Kennametal composition that cuts cast iron at greatly accelerated rates, with amazing tool life.*
- *a complete line of machining tools, designed to make fullest utilization of possibilities inherent in Kennametal compositions.*
- *Kennametal lathe files, that outlast steel files up to 200 times, and produce a superior finish.*
- *a wide variety of wear-resistant products, including lathe and grinder centers, pump valve balls and seats, gage tips, etc.*
- *negative-rake carbide milling cutters, notable among which is the widely used inserted-blade Kennamill step-cutter.*

Research—looking to still further improvement in the properties and applicability of Kennametal—will continue, and expand, so long as the useful products of inventive genius are protected under an uninhibited American system of free enterprise.

KENNAMETAL

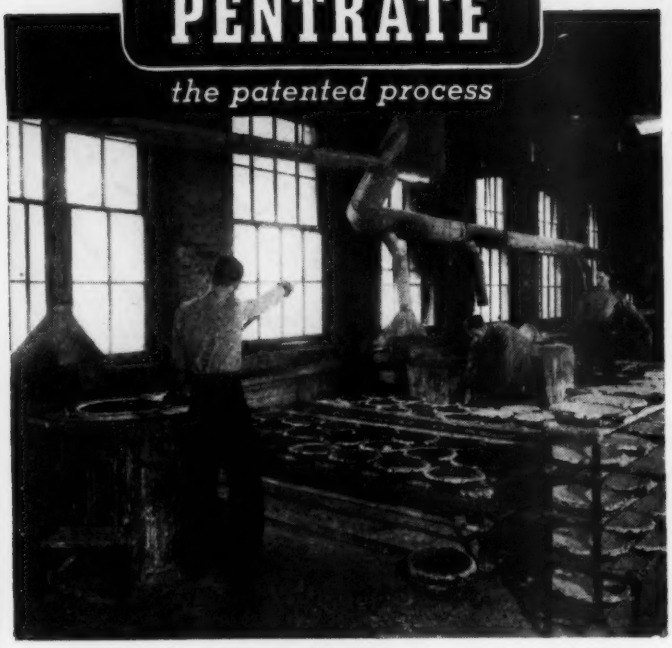
SUPERIOR CEMENTED CARBIDES

KENNAMETAL Inc., LATROBE, Pa.

Solution Stability In A Black Finish For Steel

PENTRATE

the patented process



Pentrate's solution stability results from the rigid control of the manufacturing process at every stage.

Pentrate is compounded and blended mechanically and by controlled fusion to insure permanent solution stability. Pentrate solutions do not break down or change with continued use and do not require periodic complete replacements.

Pentrate is an actual penetration of metallic surfaces without dimension change. It imparts a durable and attractive black finish that is rust resisting. Pentrated surfaces definitely reduce friction on moving parts. This has been proved by laboratory tests and by production runs.

More than 20 years of constant research in Heatbath laboratories enable Pentrate to offer the most in economy in speed and production work. The inherent stability of Pentrate solutions requires no energizers or periodic solution renewal.

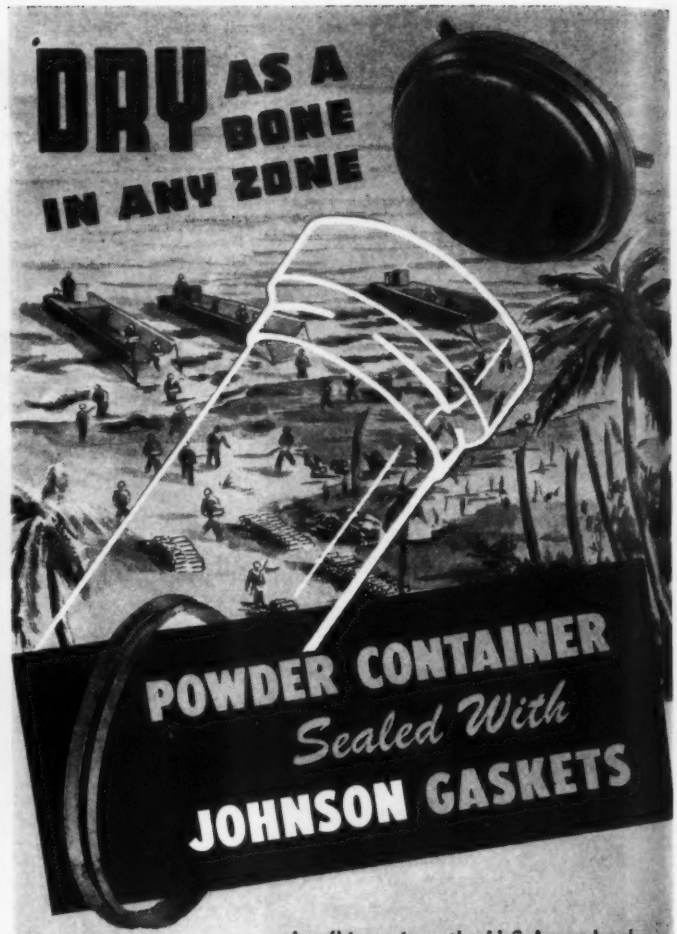
The established and proven simplicity of Pentrate operation does not require specially skilled labor.

Write for a free catalog, today.

HEATBATH CORPORATION

Springfield 1, Massachusetts

In Canada—William J. Michaud Co., Ltd., Montreal



In all invasions the U. S. Army backs its soldiers up with plenty of ammunition, on time and in good firing condition. It is extremely important that the powder used for these big powerful guns is bone dry, otherwise the velocity and firing accuracy would be greatly impaired.

Johnson Rubber Company engineers developed a new LAVELLE Double-Seal Gasket for sealing 155 millimeter powder containers, which are used by the Army for making them absolutely tight. There have been many instances where powder containers have been floated into shore during the heat of action and when opened, powder was found perfectly dry and in good firing condition.

Out of dire necessity our engineers have developed many new rubber items, such as the LAVELLE Gasket. They know rubber and how to put it to work.

We have the facilities in our modern plant to produce rubber parts in great quantities. Our engineers and staff have had the experience in developing and delivering the products on schedule. If you have a problem, send it on, you'll find we're aggressive, eager to serve, and easy to do business with.

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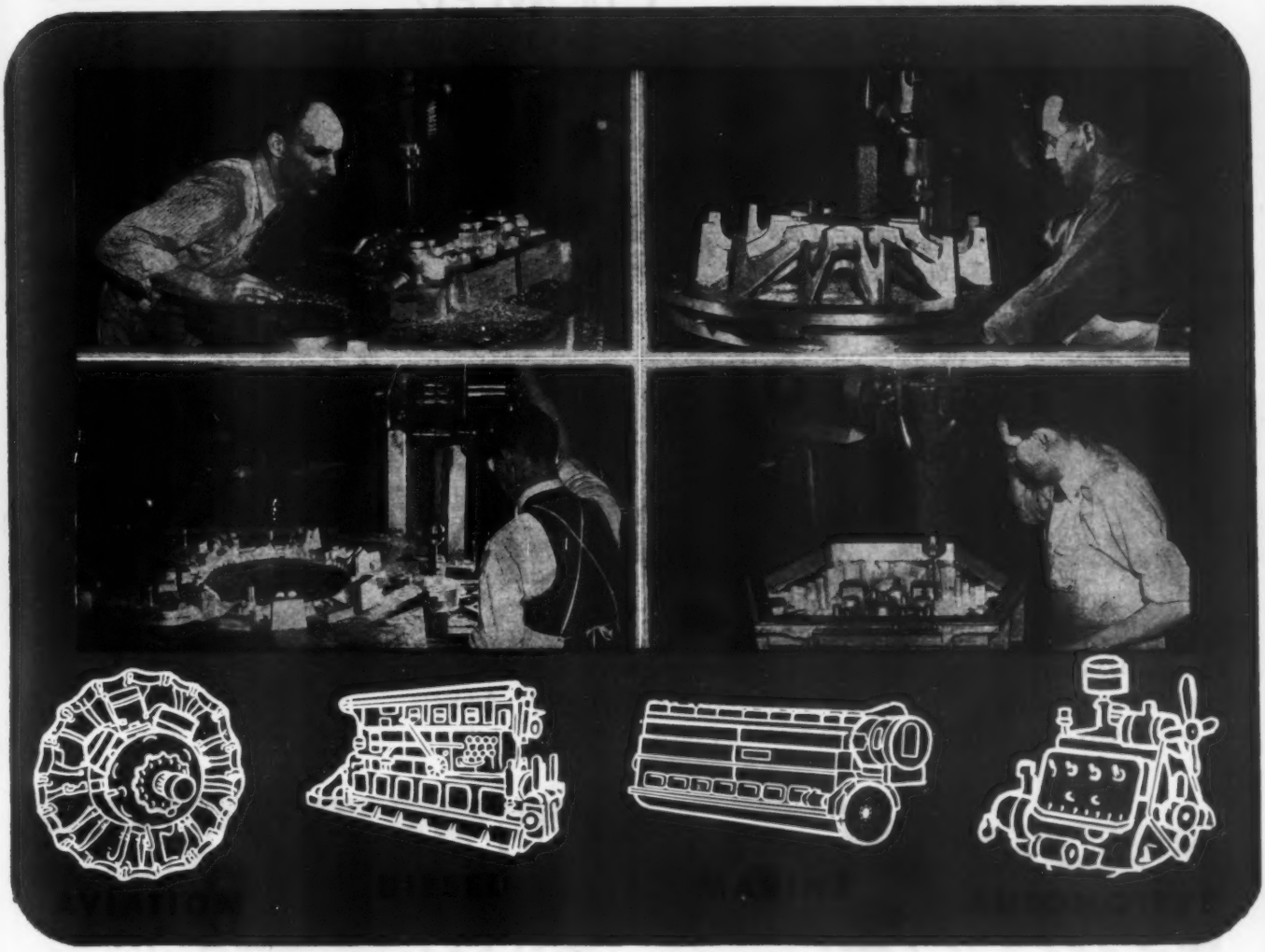
Middlefield, Ohio U.S.A.

BUFFALO *Precision* PATTERNS

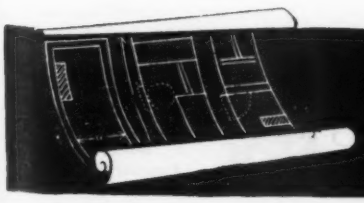


When Thousandths of an Inch Count... Leading Manufacturers Count on **BUFFALO**

● Accuracy is our business! At Buffalo Pattern Works we combine skill and know how in layout with a wide knowledge of metals, structural design and practical fabrication.

Thus, every Buffalo Pattern is a precision pattern—engineered to meet your stiffest requirements for split hair accuracy without sacrificing metallurgical soundness—designed to enable speedy, low cost production of the most intricate castings.

Many of America's leading automotive, aircraft and marine manufacturers rely on Buffalo Precision Patterns. Consult us now on your most difficult present or postwar pattern problem. Write or wire Dept. D.



"I'M GOING NUTS!" I HOWLED

These pencils are as uniform as a handful of pebbles!

Take it easy, Bill. Get yourself the right pencils—Typhonite Eldorado. They're honeys! Their leads are dependably true in every degree. The points stand up under pressure, too.

And draw? Boy! Eldorado will give you beautiful lines—dense, clean, sharp and brilliant. Eldorados are made by specialists who know what a draftsman wants. There's a free Comparison Sample waiting for you, Bill—and for all draftsmen who send the coupon below.

DIXON'S TYPHONITE

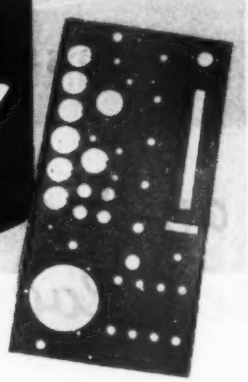
ELDORADO

Pencil Sales Dept. 20-J4
Joseph Dixon Crucible Co.
Jersey City 3, N. J.

Gentlemen: Please send me a free Comparison Sample of Typhonite Eldorado drawing pencil.....degree.

Name.....
Address.....
City.....State.....

There is no substitute for PRECISION in metal parts fabrication



"This instrument panel is representative of the accuracy and tolerance specifications regularly handled by OLYMPIC. Critical electronic applications are ordinary production here."

Mass production methods demand high dimensional accuracy today, particularly where replacement parts must be readily interchangeable. The experience and manufacturing techniques of OLYMPIC assure strict adherence to dimensional limits in sheet metal working.

OLYMPIC metal fabrication facilities are available for the accurate and precise fulfillment of your needs. Stamping, forming, tooling, turning, drawing, grinding, soldering, welding or brazing, etc.—all are accomplished to your exact specifications. Any finish can be supplied.

OLYMPIC TOOL & MFG. CO., INC.
39 CHAMBERS ST., NEW YORK 7, N. Y.

CRAFTSMANSHIP JM IN METAL PARTS

What Do You Know About Centrifugal Castings?

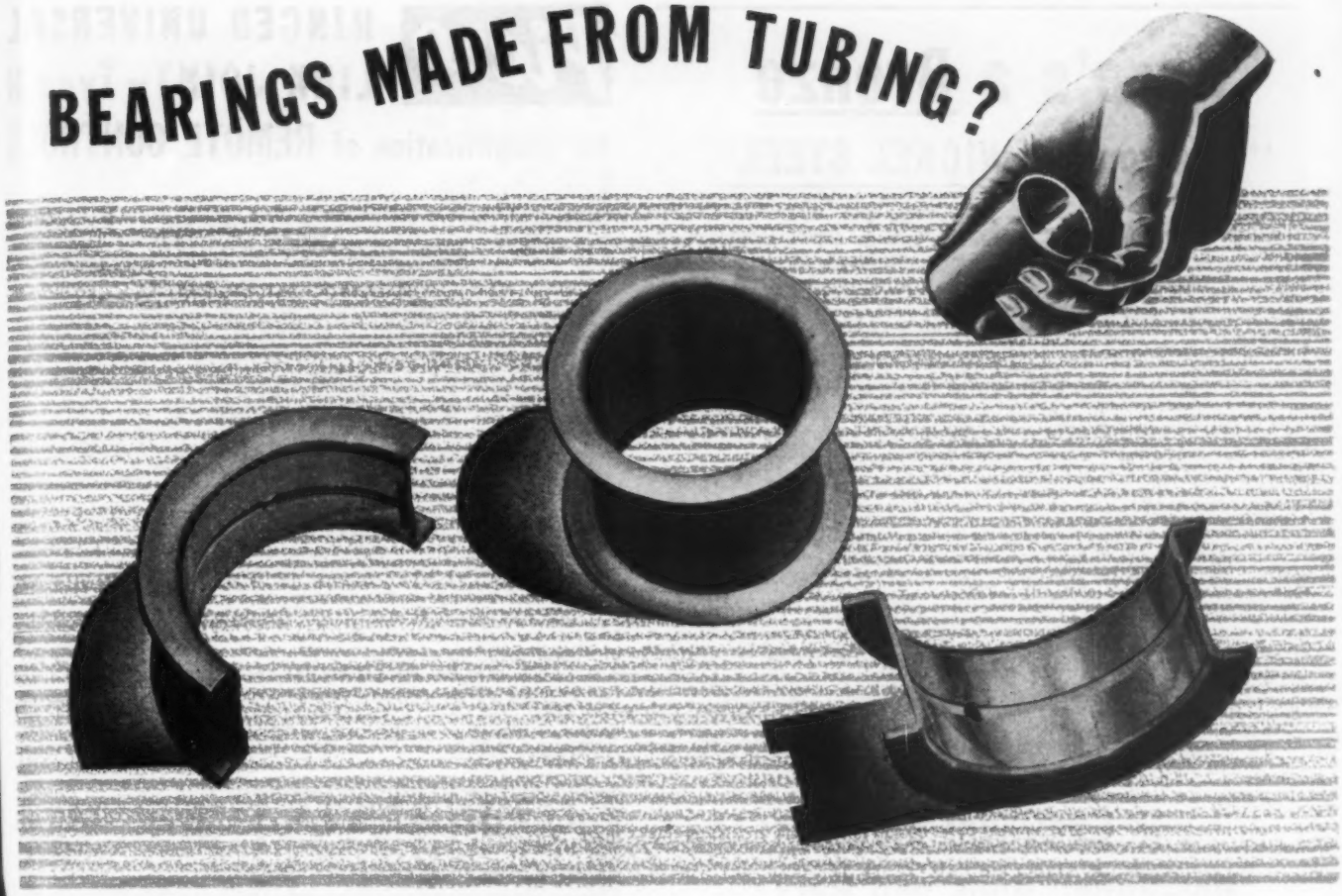
● Centrifugal bronze castings, made by Shenango-Penn, are so strong and dense and durable that they approach forgings in their physical qualities. They are being used as bearings, bushings, rings, sleeves, liners and other tubular parts for engines, machines and equipment of many types — wherever a close-grained, uniform metal is desired.

Get your copy of Bulletin 143 which gives specifications of available alloys, physical properties, sizes, applications, etc. Free for the asking.

SHENANGO-PENN

SHENANGO-PENN MOLD COMPANY
651 West 3rd Street, Dover, Ohio
Executive Offices: Pittsburgh, Pa.

BEARINGS MADE FROM TUBING?



Here they are—

Yes, these automotive bearings were made from standard 2″ O. D. x 14 gauge Republic ELECTRUNITE Tubing—cut, flanged, machined and drilled as shown above.

Here is *proof* of the workability of ELECTRUNITE Tubing . . . *proof* that it offers you the easy-to-work characteristics which mean higher rate of output and lower unit production cost . . . *proof* that you should consider the possibilities of using this versatile, modern tubing in your own manufacturing operations.

ELECTRUNITE Tubing is highly uniform in diameter, wall thickness, concentricity, strength, weight, tolerance, ductility and scale-free surface—because it is made by the electric resistance weld process—*the only process* which insures these qualities consistently, in every length.

ELECTRUNITE engineers will be glad to help you in determining where ELECTRUNITE Tubing can be *profitably* used in fabricating your present and anticipated postwar products. Just write us.

REPUBLIC STEEL CORPORATION
STEEL AND TUBES DIVISION • CLEVELAND 8, OHIO
Export Department: Chrysler Bldg., New York 17, N. Y.

Republic
ELECTRUNITE TUBING
Reg. U. S. Pat. Off.

Mechanical, Aircraft, Stainless Steel and Ball Steel Tubing—Boiler, Condenser and Heat Exchanger Tubes

Here's a Bronze

"as strong as NICKEL STEEL"

HY-TEN-SL
A Bronze as Strong as Nickel Steel
TRADE-MARK

Grade of HY-TEN-SL	1AA	1A	1	2	3	4
TENSION				(Minimums)		
Ultimate tensile strength lbs. per sq. in.						
Sand Cast	125,000	115,000	108,000	100,000	90,000	85,000
Rolled 1" and under	.....	120,000	110,000	105,000	95,000	85,000
Rolled or Forged, over 1"	.....	115,000	108,000	100,000	90,000	85,000
Yield Point (divider method)						
Sand Cast	95,000	75,000	60,000	55,000	45,000	40,000
Rolled 1" and under	.....	75,000	65,000	60,000	50,000	45,000
Rolled or Forged, over 1"	.....	75,000	65,000	60,000	50,000	45,000
Elongation in 2"—%						
Sand Cast	10	12	14	15	20	25
Forged or Rolled	.....	12	13		15	20
Reduction in area—%						
Sand Cast	.....	12	14	15	20	25
Forged or Rolled	.....	12	13		15	20
COMPRESSION						
Yield Point—lbs. per sq. in.	70,000	65,000	58,000	50,000	40,000	35,000
Permanent Set at 100,000 lbs. per sq. in. (max.)	.015	.020	.030	.050	.080	.125
Brinell hardness, No.	250	240	220	200	175	150

List of U. S. Government Specifications Covering HY-TEN-SL Bronze

ARMY
Forgings, Rolled Rod QQ-B-721 Class B
Castings...QQ-B-726 Class B and C

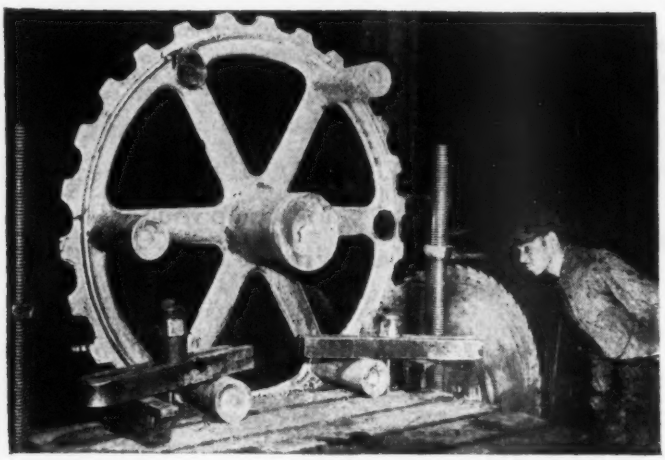
NAVY
Forgings and Rolled Rod 46B15d Class B
Castings, Aluminum-manganese Bronze 46B29

WATERTOWN and OTHER ARMY ARSENALS
Castings WXS-5
Forgings and Rolled Rod.....WXS-2

NAVAL GUN FACTORY
Washington Navy Yard
Castings—Trunnion Metal.....O.S.550

AIRCRAFT
See Navy and Army (above).

. . . in Castings; Forgings; Hot-Rolled Rods and Bars



Manganese Bronze Sprocket for Ammunition Conveyor, 52" dia., 475 lb. each.

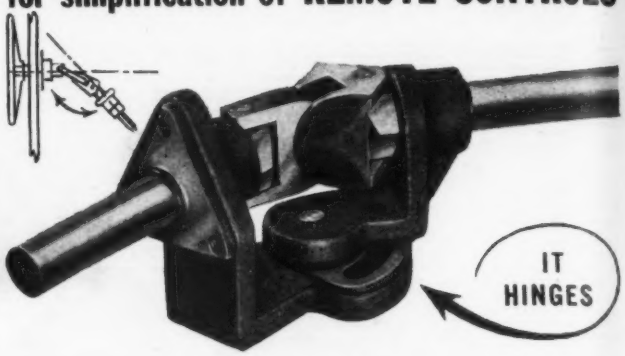
Hy-ten-sl is an aluminum manganese bronze,—and being the *strongest and toughest Bronze known*, it has for years been used for the most severe and exacting service. It is shock and fatigue resisting, pressure tight, erosion resisting and corrosion resisting to the elements and certain acids;—further, it is non-magnetic, light in weight, and wear resisting under heavy, slow-moving loads.

Write us for literature and particulars

AMERICAN MANGANESE BRONZE COMPANY
4704 Rhawn St. Holmesburg, Philadelphia 36, Penna.
NEW YORK CITY • PITTSBURGH, PA.
35 YEARS' EXPERIENCE

Piezo HINGED UNIVERSAL LINK JOINT—Type H

for simplification of REMOTE CONTROLS



The type "H" hinged Universal Link Joint with solid shafting has three distinct advantages for remote controls. (1) Simplicity of installation (the Universal Link Joint hinges from 0 to 90°). (2) A minimum of backlash. (3) Output shaft turns in exact angular rotation with the input shaft.

Write for Bulletin 45 B for complete data and specifications.

This method is recommended for use in air-conditioning equipment, aviation, railroad equipment, petroleum and chemical industries, electronics, machine tools and other machinery.

PIEZOELECTRIC CORPORATION
110 E. 42nd ST., NEW YORK 17, N. Y.

Cottonleather

PLASTICIZED COTTON FABRIC *

SHEET STOCK *for* INDUSTRY

*CONTAINS NO LEATHER

Competitor To:
Rubber, Felt, Leather, Linoleum, Terrazzo, etc.

In a Range of Thicknesses:
3 iron (.063"), 5 iron (.110"), 7 iron (.141"), etc.

For Abrasion Resistance:
With stable fraction, mechanical strength, and flexibility or rigid forming.

And Easy Working:
Cuts, drills, nails, paints, varnishes, and cements like **wood** but wears like **iron.**

In Such Applications As:
Oil seals, polishing wheels, safety flooring, clutch facings, shoe soling, protective moldings, etc.

With Resistance To:
Heat, water, oil, weak alkalies, weak acids, mildew, etc.

And In a Variety Of Finishes:
Plain, sized, coated (oak or walnut), etc.

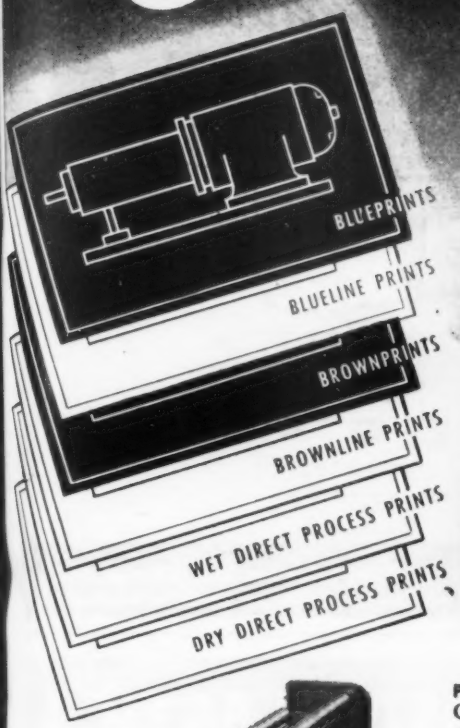
Available In:
Sheets, squares, rectangles, doughnuts, etc.

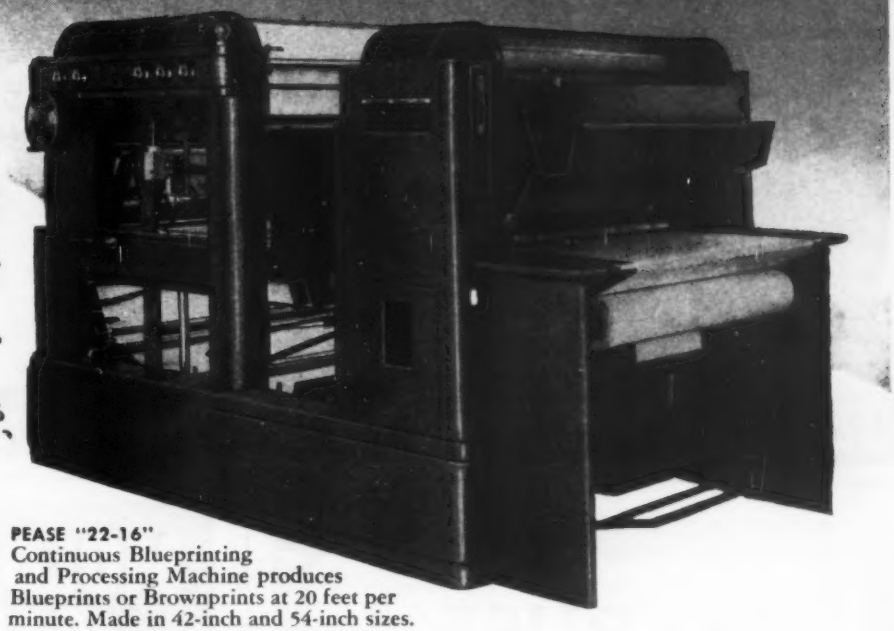
WRITE FOR CATALOG
2-12-45

SOUTHERN FRICTION MATERIALS CO.— CHARLOTTE 1, N. C.

6 DIFFERENT KINDS OF TRACING Reproductions

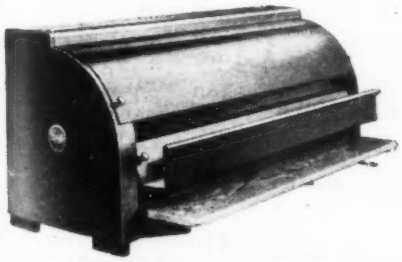
WITH PEASE BLUEPRINTING MACHINES
BASIC EQUIPMENT FOR MAKING
VARIED PRINTS USED TODAY





PEASE "22-16"
Continuous Blueprinting and Processing Machine produces Blueprints or Brownprints at 20 feet per minute. Made in 42-inch and 54-inch sizes.

PEASE "K" Wet Direct Process Developing Attachment bolts securely to top of Printer and applies developer to the exposed prints which are dried and delivered in the same manner as Blueprints.



PEASE "700" Dry Direct Process Developing Unit is a table style, ammonia fume machine for developing the prints after exposure in the Printer. It is continuous in operation and has two developing speeds, 4 ft. and 8 ft. per minute.

USE PEASE "22-16" (above), or any other Pease Continuous Blueprinting and Processing Machine as the *basic* equipment for your reproduction department . . . Add a Pease "K" Attachment (left) to the printer for making wet direct process prints . . . and a Pease "700" Developer (left) for making dry direct process prints.

Simple, that's all there is to it. Your department is complete and capable of handling volume production of —

1. **BLUEPRINTS**
   White lines on Blue
2. **BLUELINE PRINTS**
   Blue lines on White
3. **BROWNPRINTS**
   White lines on Brown
4. **BROWNLINE PRINTS**
   Brown lines on White
5. **WET DIRECT PROCESS PRINTS**
   Black lines on White
6. **DRY DIRECT PROCESS PRINTS**
   Red, Blue or Black on White

And what's more . . . the prints are easy to make, produced in volume, high in quality and low in cost.

Send for descriptive literature and prices, no obligation, of course.

THE C. F. PEASE COMPANY

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Pease Blueprinting Machines for all kinds of Tracing Reproductions

an Element of Victory!

"OH 38"

An Aluminum Alloy—Non-Heat Treated. The perfected metal that surpasses all others for a wide variety of machining operations. Non-corrosive—Easy on machine tools—Holds threads without stripping. Its light weight reduces table and machine loads and increases tooling accuracy. 5 years of proven superiority in hundreds of plants. OH 38 is an exclusive Hedstrom product.

Write for Literature

Easily Machinable

HEDSTROM

OSCAR W. HEDSTROM CORP. 4834 West Division St., Phone Columbus 3667, Chicago, Ill.

Manufacturers of Aluminum, Brass, Bronze and High Conductivity Copper Castings. Pattern Makers. Complete Mechanical Assemblies and Models to Specifications

Get **RUST** off your payroll!

No need for rust to cost you money. Science has found a new way to stop its needless waste. TECTYL gives you tested, proven, *positive* protection against rust or corrosion. Easy to apply and remove, economical to use—one of the five specialized Tectyl types will solve your special problem. Write today, indicating your corrosion-prevention needs, and we will send Tectyl bulletin with complete application data.

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STOPS RUST

VALVOLINE OIL COMPANY

Finest Lubricating Oils Since 1866

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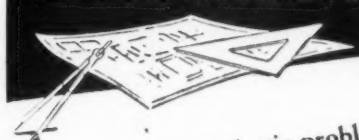
MOLDED PLASTICS

FOR WAR-TIME AND PEACE-TIME PRODUCTS



IF you have a plastic problem we invite you to take advantage of our complete facilities—Engineering and Drafting—Machine Shop—Molding dies and Molding—every operation from the drafting board to the finished molded products.

We specialize in Compression and Transfer molding of Thermosetting plastics—Mechanical rubber products to specification—and Laminated materials.

Your inquiry will be treated in strict confidence —and without obligation, of course.

TAYLOR MANUFACTURING CO.

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Another Case For The HARVILL DIE CASTING MACHINE as a production tool

Believed to be the smallest magnesium die casting ever made, this stylus chuck weighs only .000823 pounds. Used in a sound recorder, the stylus chuck moves laterally up to 10,000 cycles vibration per second. A remarkable engineering and production job, again proving the versatility of "Red" Harvill's new cold chamber die casting machine. When used as a machine tool this new machine . . . in your production line . . . will speed production and cut costs from the smallest to the largest die castings.

Case History No. 72

A simple casting replaces a laborious and intricate milling, drilling and broaching job, cutting cost over 50%. Let "Red" do the same for you.

See RED and be ready

Our total effort and output is for the armed services right now . . . but let "Red" help you plan for your postwar production . . . and your plans cannot be complete until you have discussed die casting your product.

SEND FOR THIS BROCHURE

H. L. RED HARVILL MFG. CO.
POST OFFICE BOX 335
VERNON, CALIFORNIA

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CITY STATE

RINGS

SEAMLESS, ANY SIZE

CARBON, ALLOY STEELS

● Taylor Forge, as your source of supply for steel rings, gives you these worthwhile advantages: 40 years' experience in forging and rolling annular products; the finest forging, rolling and machining equipment available; complete facilities for all types of heat treating; modern laboratory to verify specified characteristics. Here is a combination of "know-how" and facilities that is difficult to duplicate.

Inquiries are invited for rings from 12" O.D. up to 120" O.D.

OTHER PRODUCTS OF TAYLOR FORGE

"WeldELLS" and related fittings for pipe welding; forged steel flanges; forged steel nozzles and welding necks for boiler and other pressure vessel outlets; light wall spiral pipe; heavy wall electric-weld pipe; corrugated furnaces, and similar forged and rolled products.

FORGED AND ROLLED

exactly to your specifications by

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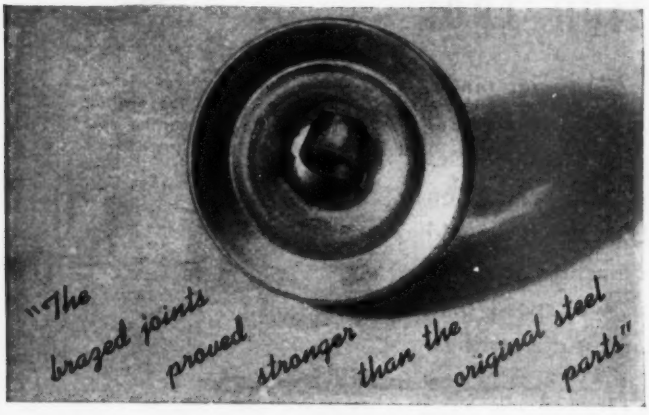
New York Office: 30 Church Street — Philadelphia Office: Broad Street Station Bldg.



Result of a test on fan pulley. Hub was brazed to web and pressure applied. The web broke but joint held securely.

Aluminum, Steel and Other Assemblies

Are Securely & Economically Joined

In EF Brazing Furnaces

Design your metal parts for furnace brazing. Products difficult or expensive to make in one piece can be made in several pieces and joined. Products requiring several stampings joined or requiring screw machine parts, forgings and stampings to complete the unit, can be neatly, and economically joined right in your production line.

Strong, leak-proof joints are made and the completed unit is discharged from the furnace—clean and bright. Any number of joints in the same product or any number of pieces can be joined at one time.

Investigate This Process for Joining YOUR Metal Parts

Send for printed matter showing various types of EF brazing furnaces.

The Electric Furnace Co., Salem, Ohio

Gas Fired, Oil Fired and Electric Furnaces—For Any Process, Product or Production

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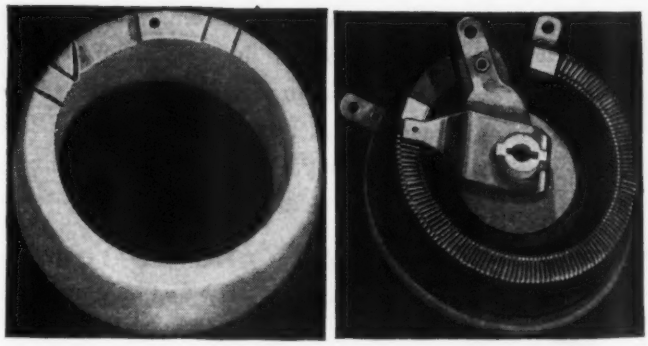
THE WIRE IS WOUND ROUND AND ROUND



THIS UNIVERSAL PORCELAIN CORE

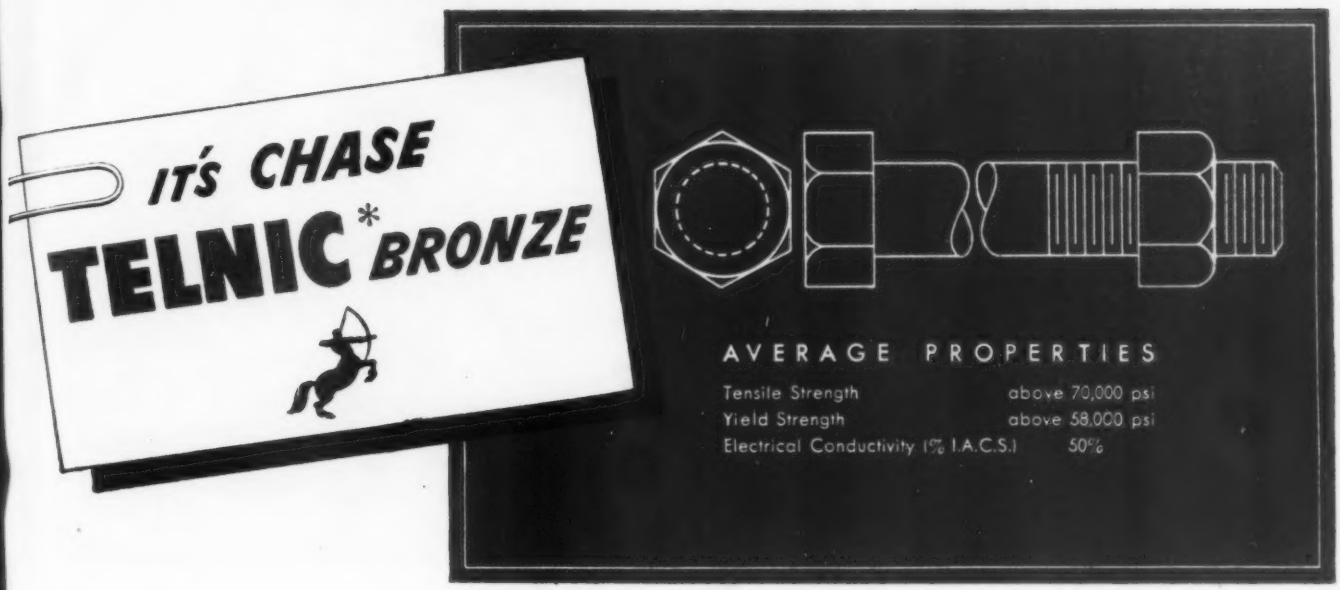
Ohmite Vitreous Enamel Rheostats have won an enviable reputation with engineers and in industry. And each Ohmite rheostat going into service adds proof to the evidence that Universal porcelain parts have definite advantages in electrical applications of rigid performance requirements. Universal genuine porcelain insulators have high dielectric strength; withstand thermal shock and arcing; are non-corrosive; resist acids and will not carbonize because they contain no organic binders. Send blueprints of parts and specifications for estimate. No obligation.

THE UNIVERSAL CLAY PRODUCTS CO.

1545 EAST FIRST STREET • • SANDUSKY, OHIO

There's a NEW

MATERIAL FOR PARTS LIKE THIS...



YES, the copper alloys, too, are new materials today — materials you will want to study carefully when you plan your postwar designs.

For instance — there's TELNIC Bronze, the first high copper content alloy to combine high corrosion resistance, excellent hot workability, free cutting characteristics, age hardenability, high strength and hardness.

Older copper alloys depended on lead for free machining properties — and lead is highly detrimental to hot working. But TELNIC Bronze uses carefully controlled quantities of *tellurium* in place of lead, making this alloy free machining without affecting its hot working characteristics in any way.

For any part that can best be fabricated by a combination of hot forging and machining . . . and that must have high strength, excellent corrosion resistance, and reasonably good conductivity . . . you will find TELNIC Bronze an ideal material. Right now, of course, it is being used entirely for war applications . . . but we'll be glad to work with you in adapting its unique properties to your postwar plans.

*Reg. U.S. Pat.

CHASE BRASS & COPPER CO.

—Incorporated—

Waterbury 91, Connecticut

SUBSIDIARY OF KENNECOTT COPPER CORPORATION

ALBANY† ATLANTA† BALTIMORE BOSTON CHICAGO
CINCINNATI CLEVELAND DETROIT HOUSTON
INDIANAPOLIS† KANSAS CITY, MO.† LOS ANGELES MILWAUKEE

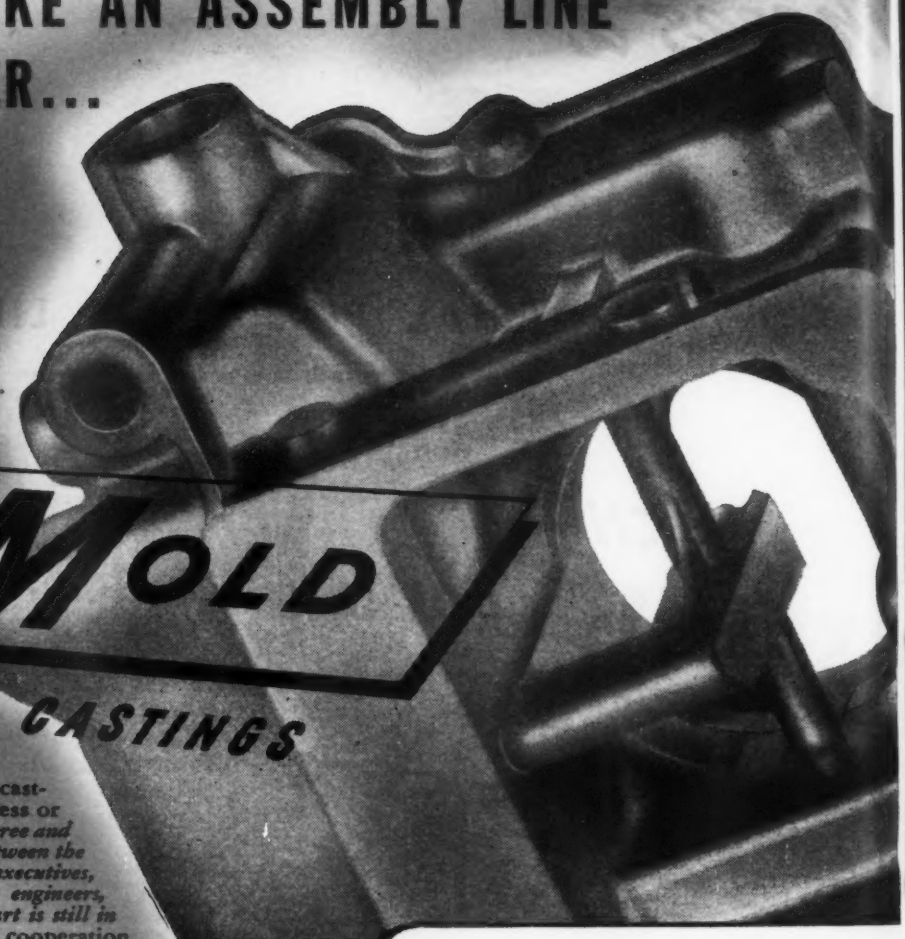
MINNEAPOLIS NEWARK NEW ORLEANS NEW YORK
PHILADELPHIA PITTSBURGH PROVIDENCE ROCHESTER†
SAN FRANCISCO SEATTLE ST. LOUIS WASHINGTON†

† *Indicates Sales Office Only*

This is the Chase Network — handiest way to buy brass

HOW TO MAKE AN ASSEMBLY LINE MOVE FASTER...

Do first things first. The design of a part usually determines the rate of production, as well as the quality and cost of the part, regardless of the material used or the method by which the part is formed. To obtain all the advantages offered by permanent-mold-castings, designing must be done especially for permanent-mold-casting techniques.



PERMOLD ALUMINUM CASTINGS

Whether a permanent-mold-casting application results in success or failure *is determined by the degree and thoroughness of cooperation between the design engineer, production executives, and permanent-mold-casting engineers, and metallurgists while the part is still in the design stage.* Thorough cooperation insures utilizing fully the excellent physical properties and heat treatment potentialities of aluminum alloys. A permanent-mold-casting specialist can be more helpful to the design engineer than the aluminum alloy manufacturer because of his technical knowledge of the wide range of possibilities obtainable with permanent-mold-casting techniques.

Permanent-mold-casting techniques develop, by the chill effect of the metal mold, maximum strength and soundness inherent in aluminum alloys. This strength can be increased by heat treatment to a point that cannot be equalled by castings made by any other process. Higher strength, plus uniformity in casting quality, permits the use of a much lower factor of safety in designing; hence, that greatly desired combination of high strength in lighter weight sections.

The design engineer who would avoid the pitfalls of misapplication that penalize development, will invite the cooperation of a Permold Engineer or Metallurgist whose objective is to help you achieve the lowest piece price for each part at the point of assembly. This involves: (1) employing the correct permanent mold casting technique; (2) taking advantage of the savings available through the use of metal from re-melt sources; (3) a simple, straightforward design which permits a high rate of mass production with minimum scrap loss in machining and processing. A Permold Engineer or Metallurgist is backed by over 24 years of venturesome technical and foundry experience. Consult him before the design is fixed.

perMold

A Permold Engineering and Metallurgical Review brings you:

1. **Sound engineering experience** (24 years) in utilizing aluminum alloys, and in developing permanent-mold-casting techniques, to meet a wide range of service requirements.
2. **Design suggestions**, resulting from hundreds of applications of permanent-mold-castings, to guide you in obtaining unusual savings available through the use of high strength aluminum alloys and lighter weight sections.
3. **Recommendations covering correct combinations of physical properties** required to meet given service conditions; and how to utilize the excellent physical properties and heat treatment potentialities of aluminum alloys to protect your product against failure.
4. **Estimates of cost-reducing possibilities** which may be realized through the use of permanent-mold-castings and metal from re-melt sources.
5. **Technical facts** resulting from comparisons of materials, processes, and costs usually overlooked and unappreciated except by those of broad specialized experience in the highly skilled art of permanent-mold-casting on a mass production basis.

THE PERMOLD COMPANY

900 WEST LIBERTY STREET • MEDINA, OHIO

In the Cleveland Industrial Area

SEARCHLIGHT SECTION

(Continued on pages 360-361)

WANTED

MECHANICAL ENGINEERS AND DRAFTSMEN

Experienced in development and design of machine tools, special, medium, and heavy machinery.
Wanted by large glass manufacturing company in midwest.
Give complete details of personal qualifications, age, draft status, work history, present earnings and salary expected in letter of application. W.M.C. regulations apply.

P-938, Product Engineering
520 North Michigan Ave., Chicago 11, Ill.

CIVIL SERVICE

METALLURGISTS — for positions in Bureau of Mines, Naval shore establishments and War Dept. arsenals. Salaries, including overtime pay, range from $2,433 to $6,228. Full information and application forms at first and second-class Post Offices or United States Civil Service Commission, Washington 25, D. C.

POSITIONS VACANT

ENGINEER-MECHANICAL and electrical production. Must have 10-15 years experience. Location East. Must be willing to travel. Give full qualifications 1st letter to C-62, P.O. Box 3675, Phila. 22, Pa.

WANTED: Electrical and mechanical engineers, mechanical designers, and draftsman. Established motor and fan manufacturer, located in Middle West, has opportunities in engineering department for men of experience or suitable background. Excellent post-war future. P-933, Product Engineering, 520 N. Michigan Ave., Chicago 11, Ill.

WANTED: ENGINEERS We are a Cleveland, Ohio, firm in the same business for ten years. We can offer a very interesting and attractive position with excellent chances for advancements, to top-notch machine designers who can do board work and act as project engineer, to head up engineering projects and direct the efforts of layout and detail draftsman on product design and development work. We have also several openings for design, layout, and detail draftsmen, who are willing and able to advance into more responsible positions. Interesting and important work for the duration and an excellent postwar future. Write giving details to P-934, Product Engineering, 520 N. Michigan Ave., Chicago 11, Ill.

WANTED: DESIGNING Engineer—for development and layout work of electrical and mechanical household appliances. Applicant must have experience in this type of work. This is a permanent position with a well known New England concern. State age, marital status, education and experience in reply. P-935, Product Engineering, 330 W. 42nd St., New York 18, N. Y.

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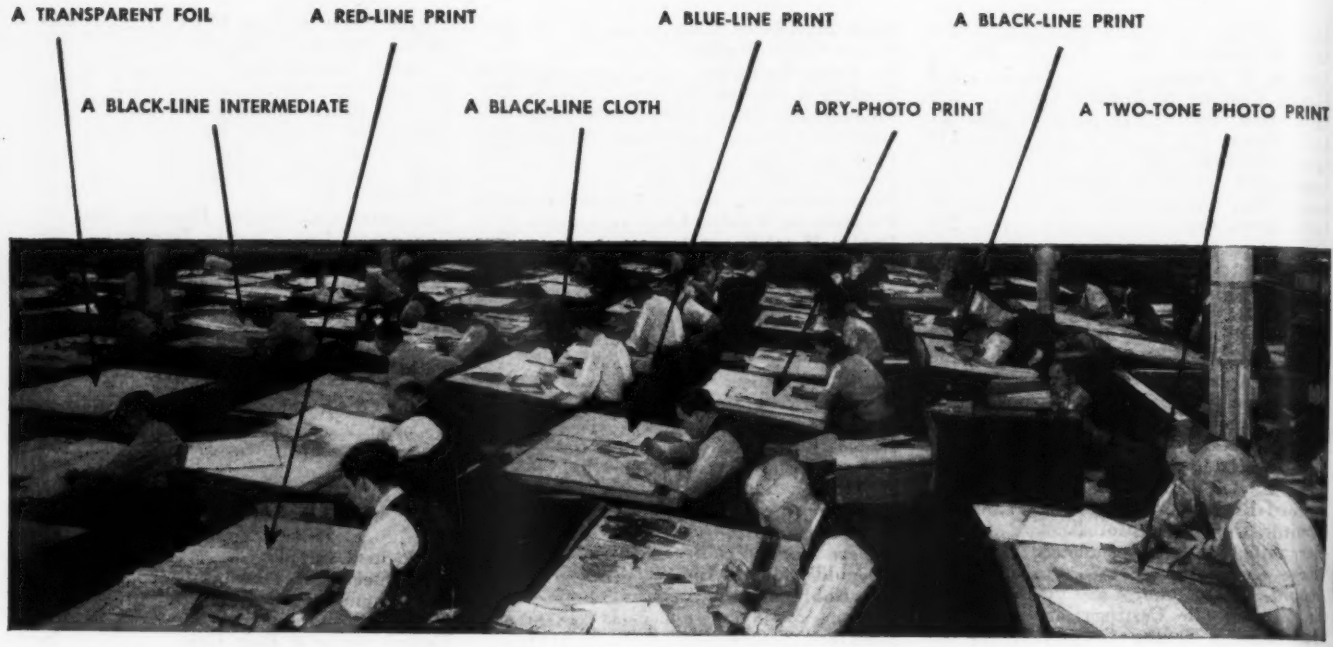

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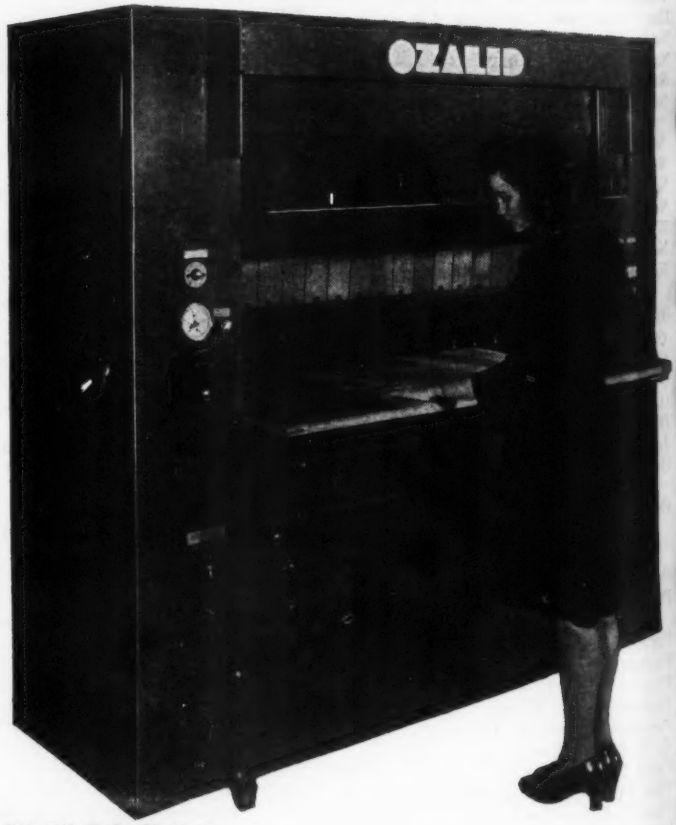
IMPOSSIBLE when you rely entirely upon blueprint or semi-moist machines. Impossible because "wet" development gives you no choice.

POSSIBLE when you have an Ozalid Whiteprint machine (which prints and dry-develops) or an Ozalid Dry-developer which you can use with your present printer.

POSSIBLE because Ozalid eliminates chemical baths and driers . . . and allows the use of a really amazing variety of sensitized materials which react ONLY to the unique "dry" process.

SEE these prints yourself. Learn how quickly you can produce them, how you can save by using them in ALL departments.



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OZALID PRODUCTS DIVISION

GENERAL ANILINE & FILM CORPORATION, JOHNSON CITY, NEW YORK

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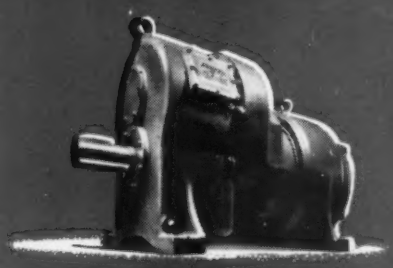
WRITE for free booklet of Ozalid Whiteprints and catalog, TODAY.



1/10 TO 100 HORSEPOWER
Five types of gearhead motors have reduction ratios ranging up to 432:1.

available in combinations of all these types

HIGH EFFICIENCY
More efficient than other types of slow speed drives . . . only 2% power loss in each stage of reduction, in parallel shaft type.

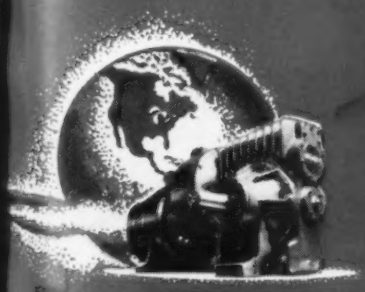
MASTER GEARHEAD MOTORS

These are the ***good reasons why*** gearhead motors met with such immediate success when The Master Electric Company originated and pioneered the first line of gearhead motors, years ago.

These are the ***good reasons why*** more gearhead motors in use today carry the Master name than all other makes . . . COMBINED.

These are the ***good reasons why*** Master Gearhead Motors will help you save money and still add greatly to the convenience, compactness and safety of your motor driven machinery. For best results, use them for either your plant or your products.

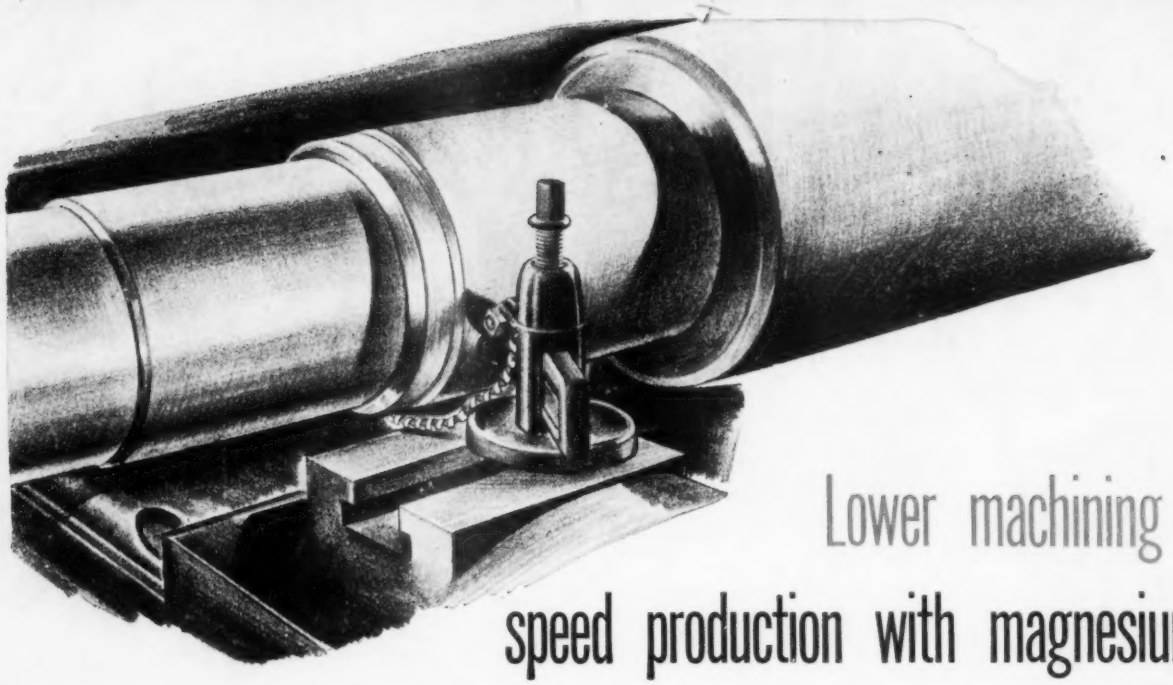
THE MASTER ELECTRIC COMPANY ● DAYTON 1, OHIO



PROVEN RELIABILITY
Their durability and stamina have been proven with millions of hours of service all over the world.

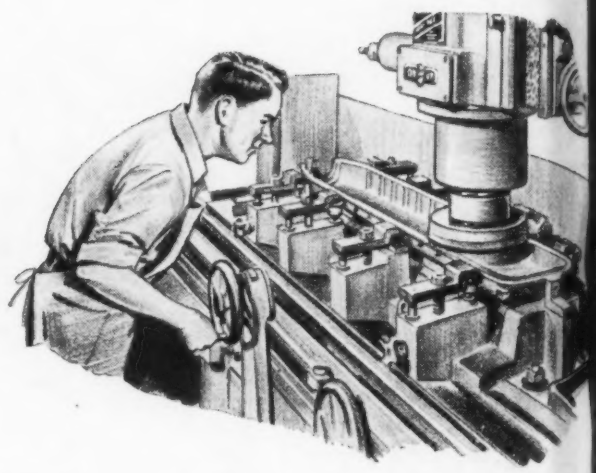
UNDIVIDED RESPONSIBILITY
The complete Gearhead Motor is designed and built by one manufacturer in one plant.

COMPACT
Integral, compact design saves space, saves money, improves appearance.



Lower machining costs-
speed production with magnesium alloy

Dow engineers . . . backed by unmatched experience are ready to work with you



You know magnesium can save you weight . . . *but just wait till you start to machine it!* That's when you meet another big magnesium economy factor —the savings in time and power and tools.

Magnesium alloys can be machined at exceptionally high speeds—often at the top speeds of modern machine tools. Heavier depths of cut and higher rates of feed are also standard magnesium practice. And when you remove a given amount of magnesium, you use noticeably less power than for other common structural metals.

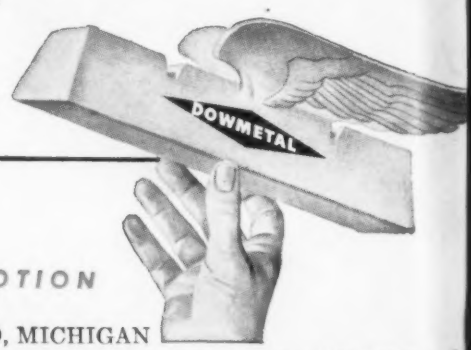
Tool life is considerably extended when you turn to magnesium, especially if you use carbide tipped tools . . . another saving!

Dow has spent more than a quarter century in magnesium development work, and maintains a trained staff always seeking still more improvements. These technicians are on call to work with you. For consultation, simply contact the nearest Dow office.

DOWMETAL

magnesium

THE METAL OF MOTION



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